BARRIERS TO RENEWABLE ENERGY DEVELOPMENT IN NEWFOUNDLAND AND LABRADOR: A CASE STUDY OF WIND ENERGY APPLYING THE 'AKTESP' FRAMEWORK FOR ANALYSIS

by

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ABSTRACT

Despite vast research on the need to transition to renewable energy (RE), fossil fuels remain the world's primary energy source. This thesis contributes to the energy transition (ET) literature by identifying barriers to RE development in Newfoundland and Labrador (NL). Applying Trudgill's 'AKTESP' analytical framework, the study asked: in a provincial context, (1) what barriers exist to wind energy development (W.E.D), (2) what are the potential benefits of W.E.D, (3) based on barriers identified, which policy measures would facilitate ET? Seventeen expert interviews were conducted and content analysis was applied using NVIVO software. A large majority of respondents (65%) classified the current state of W.E.D in NL as 'unfavourable'. The most frequently reported barriers were political (71% of respondents), economic (65%), and knowledge-related (53%). Potential benefits of W.E.D were economic, environmental, and societal in nature. Based on the findings, an ET framework was developed, consisting of seven policy recommendations which may help NL transition to RE.

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List of Symbols and Abbreviations

ACOA – Atlantic Canada Opportunities Agency
APEC – Atlantic Provinces Economic Council
AKTESP – Agreement, Knowledge, Technology, Economic, Social, Political
BTUs – British Thermal Unit
C02 – Carbon Dioxide
CAES – Compressed Air Energy Storage
CAPP – Canadian Association of Petroleum Producers
CWEA – Canadian Wind Energy Association
DNR – Department of Natural Resources
EIA – Energy Information Administration
ENGO – Environmental Non-Governmental Organization
EPA – Environmental Protection Agency
ESD – Ecologically Sustainable Development
EWEA – European Wind Energy Association
GCREB – Grenfell Campus Research Ethics Board
GDP – Gross Domestic Product
GHG – Greenhouse Gas
GNP – Gross National Product
GW – Gigawatt
GWEC – Global Wind Energy Council
GWh – Gigawatt-hour
HPS – Hydrogen Pumped Storage
IEA – International Energy Agency
IISD – International Institute for Sustainable Development
ILO – International Labour Organization
IPCC – Intergovernmental Panel on Climate Change
IUCN – International Union for the Conservation of Nature
KWh – Kilowatt-hour
LCOE – Levelized Cost of Electricity
M/s – Meters per second
MUN – Memorial University of Newfoundland
MW – Megawatt
MWh – Megawatt-hour
NASA – National Aeronautics and Space Administration
NEIA – Newfoundland and Labrador Environmental Industry Association
NGO – Non-Governmental Organization
NIMBY – Not-in-my-back-yard
NL – Newfoundland and Labrador
NLEN – Newfoundland and Labrador Environment Network
NRCAN – Natural Resources Canada
NRDC – Natural Resources Defense Council
NREL – National Renewable Energy Laboratory

OECD – Organization for Economic Cooperation and Development
OPEC – Organization for Petroleum Exporting Countries
PRERI – Provincial Renewable Energy Research Institute
PUB – Public Utilities Board
PV – Photovoltaic
RDC – Research and Development Corporation
REN – Renewable Energy Network
RET – Renewable Energy Technology
RPS – Renewable Portfolio Standard
SCC – Social Cost of Carbon
SDG – Sustainable Development Goal
SSE – Steady-state Economy
UCS – Union of Concerned Scientists
UNCED – Unite Nations Conference on Environment and Development
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme
WHO – World Health Organization
WTN – Wind Turbine Noise
WWEA – World Wind Energy Association

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Chapter One: Introduction

1.1: Introduction and Justification of the Study: The Global Importance of 'Energy'

The Institute for Energy Research (n.d.) refers to energy as the 'lifeblood of society", due to energy's central role in sustaining human life on Earth. Energy is required for the provision of clean water, sanitation, and healthcare. Access to modern energy is essential for basic human needs such as lighting, heating, cooking, mechanical power, transportation, as well as telecommunications.

Apart from basic human needs, the energy sector is a key driver of the global economy; the production and transportation of the vast majority of goods and services require energy inputs. The International Energy Agency (IEA) (2015) predicts that global energy sector investments will total $68 trillion from 2015 to 2040. An example which demonstrates energy's economic importance; in 2010, Canada's energy sector – including the production, transformation, and transportation of energy products - accounted for 6.8% of Canadian GDP (Natural Resources Canada [NRCAN], 2016). In countries that are heavily dependent on energy exports, the share is even higher: 30% in Nigeria, 35% in Venezuela, and 57% in Kuwait (World Economic Forum, 2012).

Energy's importance will continue to grow driven by increased demand as nations strive to deliver electricity to all their citizens. The Energy Information Administration (EIA)

(2014) projects that world energy consumption will grow by 56% between 2010 and 2040 – while the IEA (2015) predicts that the world's appetite for electricity will lift demand by 70% by 2040. Much of this is due to the fact that approximately 1.1 billion people, worldwide, still live without access to electricity – with most concentrated in Africa and Asia. An additional 2.9 billion people rely on wood or other biomass for cooking and heating, resulting in indoor and outdoor air pollution responsible for 4.3 million deaths each year (World Bank, 2015).

Fossil fuels continue to prevail as the world's leading supply of energy sources; coal, oil, and natural gas supply approximately 82% of the global energy needs. Non-emitting sources such as nuclear power, hydroelectricity, and biofuels supply an additional 17% of global energy. This means renewable energy sources such as geothermal, solar, and wind energy provide only 1.1% of the global energy supply (IEA, 2015b).

Energy's societal and economic importance is clear; in the face of growing global demand for energy, and a critical under provision of modern and accessible electricity in many of the world's regions, it is imperative to explore cost-competitive and innovative ways to meet the world's growing energy needs.

1.2: The Challenge Faced: Natural and Societal Consequences of Climate Change

The scientific consensus is that global climate change is occurring and it is primarily driven by human activity (Intergovernmental Panel on Climate Change [IPCC], 2007). Considering the extensive environmental and social impacts predicted as a result of climate change, it is critical to research the implementation of low impact mitigation solutions.

Many of the world's leading scientific organizations state that the world is warming; according to the National Aeronautics and Space Administration (NASA) (n.d.), global average surface temperature rose by 0.6 to 0.9°C between 1906 and 2005, and the rate of temperature increase has nearly doubled in the last 50 years. Furthermore, the IPCC (2007) projects a global temperature increase of between 1.1 to 6.4°C by the end of the century. Phillip & Mitchell (2009) suggest that an overall increase in temperature in excess of 2°C will cause runaway environmental damage and that emissions need to be kept below 450 ppm CO_2e (carbon dioxide emissions equivalents) to avoid this consequence; however, the authors note more recent modeling suggests that 2°C was an optimistic threshold, with 1.5°C being more realistic.

Evidence suggests that the primary cause of climate change is human activity; most significantly, the burning of fossil fuels in transportation, generation of electricity, and operation of homes and businesses (IPCC, 2014). According to Sims, Rogner, and Gregory (2003) the global electricity supply sector alone accounts for the release to the atmosphere of over 7,700 million tonnes of carbon dioxide annually, or approximately 37% of total emissions. Greenhouse gases act like a blanket around the Earth, trapping energy in the atmosphere and causing it to warm. This process is referred to as the greenhouse effect, it is a natural and necessary process to support life on earth. However, the buildup of greenhouse gases can change the planet's climate and result in dangerous effects to human health and welfare and to ecosystems. The IPCC (2014) has concluded that "Human interference with the climate system is occurring, and climate change poses risks for human and natural systems" (p.3). Some of the most cited consequences of climate change are explored further below to highlight the impact of human activity.

Some of the most cited environmental consequences of climate change include more frequent and severe extreme weather events, sea-level rise, and damage to ecological systems. For example, in 2003, European countries faced an unprecedented heat wave, which caused severe health problems for humans – particularly in France, where 15,000 extra deaths occurred. Mazdiyasni and AghaKouchak (2014) conclude in their analysis that from 1960 till 2010 concurrent droughts and heat waves such as the 2003 European heat wave are occurring with increased frequency due to the impacts of climate change. Over the 21st century, the IPCC (2013) report projected for a high emissions scenario, that global mean sea level could rise by 52-98 cm. Sea level rise can have severe impacts on coastal settlements and marine ecosystems; for example, a recent study analyzed the impact of sea level rise on more than 1,200 islands in the Southeast Asian and Pacific regions. The researchers found that between 3 and 32 percent of the coastal zone of these islands could be lost from primary effects depending upon the sea level rise scenario; and approximately 8 to 52 million people in the region could become flood refugees (Wetzel, Kissling, Beissmann, & Penn, 2012). The National Academies report (2008) explains how climate change is expected to have two important types of ecological impacts: shifts in species ranges (the locations in which they can survive and reproduce), and shifts in phenology (the timing of biological activities that take place seasonally). The National Academies report states that 40 percent of the wild plants and animals studied are relocating to stay within their tolerable climate ranges – while species which cannot adapt are threatened by extinction. Furthermore, the National Academies reports that seasonal behaviors of many species now happen 15-20 days earlier than several decades ago – these shifts can disrupt important ecological interactions.

Climate change is predicted to have widespread social impacts including negative public health impacts, impacts on food security, as well as other types of interference with livelihoods. The World Health Organization (WHO) (2015) projects that between 2030 and 2050, climate change is expected to cause approximately 250,000 additional deaths per year, from malnutrition, malaria, diarrhea, and heat stress – the direct damage costs to health are estimated to be between US$ 2-4 billion/year by 2030. According to the Consultative Group for International Agricultural Research (2014), climate change is predicted to impact all aspects of food security, including crop yields, prices, and nutritional quality. For example, a recent review of changes in the yields of major crops grown across Africa and South Asia under climate change found that average crop yields may decline across both regions by 8% by 2050. At the same time, demand for agricultural products is estimated to increase by about 50% by 2030 (Wheeler & Braun, 2013). Extreme weather events associated with climate change can result in loss of income and productivity, death and displacement of people, increased stress for families, and higher costs for health and social services. For example, Health Canada (2009) explains how the 1998 North American Ice Storm was responsible for 28 deaths in Canada. Furthermore, over 1.6 million Canadians were affected by electrical power failure, 2.6 million people could not perform their ordinary work, and economic losses amounted to $5.4 billion.

1.3: The Case for Renewable Energy: Environmental, Economic, and Societal Benefits

Renewable energy development offers significant economic, environmental, and social benefits. Considering the wide ranging benefits of renewable energy compared to conventional alternatives, it is important to conduct research which encourages the transition from fossil fuels to renewable sources of energy. According to NRCAN (2015), renewable energy is obtained from natural resources that can be naturally replenished or renewed within a human lifespan. Renewable energy is derived directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, as well as biofuels and hydrogen derived from renewable resources. The following paragraphs aim to give an overview of the benefits of renewable energy as an alternative to fossil fuels; these benefits include lower carbon content, enhancements to energy security, economic development potential, and improved public health benefits.

According to the IPCC (2014) report, the burning of coal, natural gas, and oil for producing electricity and heat is the largest single source of emissions globally. For example, coal-fired power plants produce approximately 25 percent of the total U.S. greenhouse gas emissions; while natural gas-fired power plants produce 6 percent of the country's total emissions (EIA, 2015). In contrast, most renewable energy sources produce little or no greenhouse gas emissions. According to data collected by the IPCC, life-cycle global warming emissions associated with renewable energy – including for manufacturing, installation, operation and maintenance, and dismantling and decommissioning – are minimal (Edenhofer, Madruga, & Sokana, 2012). For comparison, the combustion of natural gas emits between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour (CO2E/kWh), coal emits between 1.4 and 3.6 pounds of CO2E/kWh, wind energy emits only 0.02 to 0.04 pounds of CO2E/kWh, solar 0.07 to 0.2, geothermal 0.1 to 0.2, and hydroelectric between 0.1 and 0.5 (Union of Concerned Scientists [UCS], 2013). Increasing the supply of renewable energy sources allows the replacement of carbon-intensive sources and the significant reduction of greenhouse gas emissions. For example, a study completed by the Union of Concerned Scientists (UCS) (2009) found that a 25 percent national renewable electricity target in the U.S. would lower power plant C02 emissions by 277 million metric tons annually by 2025 – the equivalent of the annual output from 70 typical (600MW) new coal plants. According to the United Nations Environment Programme (UNEP) (2011), in order to reduce emissions to a point that will maintain the atmospheric carbon concentration target of 450 ppm by 2050, renewable resources will have to account for at least 27% of global energy supplies.

Energy security is a major challenge facing the economies of developed and developing countries, as prolonged disruptions of energy may cause major economic upheaval. The IEA (2007) defines energy as being “secure” if it is adequate, affordable, and reliable. A high dependence on a relatively limited range of suppliers can lead to an increased risk to national energy supplies. For example, members of the Organization for Petroleum Exporting Countries (OPEC) account for 75% of conventional oil reserves, while members of the Organization for Economic Cooperation and Development (OECD) account for 7% of reserves, but they consume close to 60% of the world’s oil. Similarly, over half of the world’s gas reserves are found in three countries: The Russian Federation (27%), Iran (15%), and Qatar (14%). OECD countries account for 8% of the worlds gas reserves, but consume over 50% of the world’s gas (IEA, 2007). For jurisdictions which rely heavily on imported oil and gas, investing in locally available and abundant renewable resources would enhance their energy security and reduce their dependency on volatile energy exporters.

Pursuing the development of renewable energy sources has significant economic benefits, including job creation, government revenue generation, and capital investment.

Employment in the renewable energy sector is substantial globally, directly and indirectly accounting for 3.5 million jobs in 2010 (UNEP, 2011). According to the World Wind Energy Association (WWEA) (2010), wind energy generation in particular has undergone rapid growth, with jobs more than doubling from 235 thousand in 2005 to over 550 thousand in 2009. Compared with fossil fuel technologies, which are typically mechanized and capital intensive, the renewable energy industry is more labour intensive. A research study found that the renewable energy sector generates 1.8 – 4 times more jobs per megawatt (MW) installed than conventional sources (Sastresa et al, 2010). Various levels of government collect property and income taxes and other payments from renewable energy projects; these payments can help support vital public services, especially in rural areas where projects are often located. For instance, owners of land on which wind projects are built often receive annual lease payments ranging from USD 3,000-6,000 per megawatt of installed capacity (UCS, n.d.). An example which demonstrates renewable energy's potential economic impact is provided in a Canadian Wind Energy Association (CWEA) (2013) study which suggests that wind energy can satisfy 20% of Canada's electricity demand by 2025 – the benefits of this would include CDN $79 billion in new investment, 52,000 new jobs, and $165 million in annual revenues for municipalities.

Generating electricity from renewable sources rather than fossil fuels also can offer significant public health benefits. The air and water pollution emitted by coal and natural gas-fired power plants is linked to breathing problems, neurological damage, heart attacks, and cancer. Replacing fossil fuels with renewable energy reduces premature mortality and lost workdays, as well as overall healthcare costs (Machol & Rizk, 2012). The IEA (2009) estimates that worldwide air pollution costs were more than US $254 billion in 2005, and they are expected to triple by 2030. In contrast, renewables such as wind, solar, and hydroelectric systems generate electricity with no associated air pollution emissions. The use of fossil fuels and traditional fuels impacts global biodiversity and ecosystems through deforestation, decreased water quality and availability, acidification of water bodies, and increased introduction of hazardous substances into the biosphere (UNEP, 2006). All of these impacts reduce the planet's natural capabilities to respond to climate change.

1.4: Selection of Case-Study: Barriers to Wind Energy Development in Newfoundland and Labrador, Canada

Newfoundland and Labrador (NL) is a significant producer of electricity and the provincial economy is highly dependent on the energy sector – therefore, NL represents an important case study within the field of energy policy. While the province has significant amounts of renewable energy available for development – especially wind energy potential – the province remains dependent on fossil fuels for electricity production, regional economic activity, and government revenue. Given this context, lessons learned from studying barriers to renewable energy development in NL, with a focus on wind energy, can provide guidance towards a necessary energy transition in the province and in other development contexts.

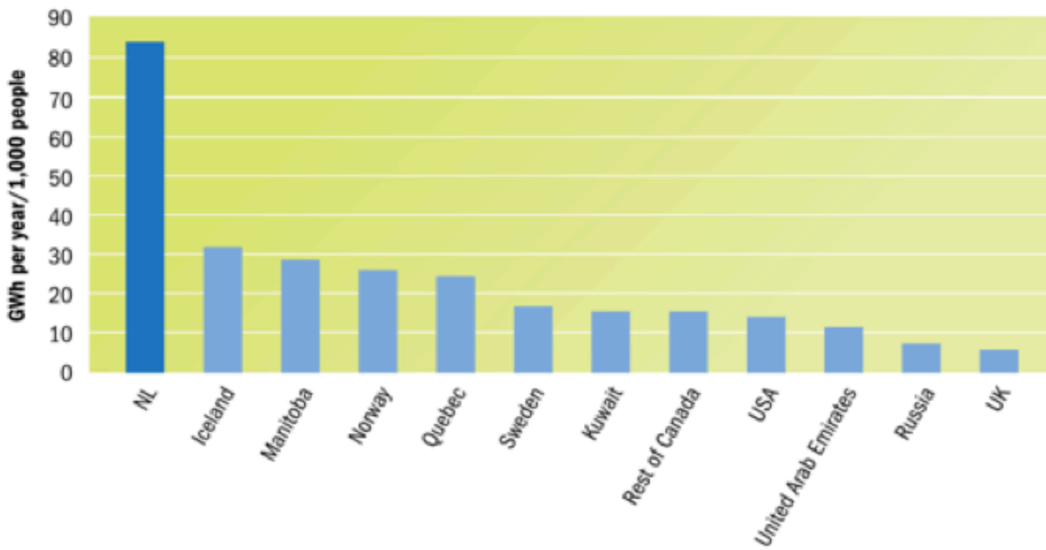
NL serves as the primary case study for the current research; the province's population is relatively small (approximately 528,000 inhabitants), but the energy sector plays a critical role in the provincial economy. In 2014, NL's energy sector accounted for 26.9% of total provincial gross domestic product; excluding Alberta, this percentage is greater than that of any other Canadian province or territory (adapted from Energy Policy and Management Centre, 2016) **(Table 1.1).**

	2007	2008	2009	2010	2011	2012	2013	2014
Alberta	31.3	34.8	25.1	27.2	28.7	25.5	26.2	28.7
Newfoundland and Labrador	**31.7**	**43.5**	**29.0**	**31.0**	**34.2**	**27.4**	**28.9**	**26.9**
Saskatchewan	25.2	27.8	22.2	22.6	23.0	23.1	22.6	24.2
Northwest Territories	16.4	17.1	11.4	10.7	10.6	11.7	11.1	10.7
New Brunswick	6.9	5.7	5.1	5.0	5.4	4.9	5.6	7.6
British Columbia	6.6	8.6	5.8	6.4	7.4	6.2	5.8	6.0
Manitoba	5.0	5.2	4.5	5.0	5.7	5.6	5.7	5.4
Quebec	4.4	4.4	4.4	4.4	4.3	4.1	4.2	4.2
Nova Scotia	7.0	8.0	4.2	4.5	4.0	3.3	3.3	4.2
Ontario	2.2	2.2	2.3	2.4	2.3	2.3	2.5	2.6
Yukon	2.8	3.0	2.0	2.1	2.0	1.8	1.7	1.7

Table 1.1: Provincial Energy Sector as Percentage of Total GDP

According to the provincial Department of Natural Resources (DNR) (2005), the largest energy sub-sectors include crude oil production, crude oil refining, petroleum product distribution, and electricity generation and distribution. According to the provincial energy strategy, on a per-capita basis, the province ranks among the largest producers of electricity globally **(Figure 1.1).** An example which demonstrates the significance of NL's energy production, despite having less than two percent of the country's population, NL produced 45% of Canada's conventional light crude and 12% of the country's hydroelectricity in 2007 (Government of NL, 2007).

Figure 1.1: Electricity Generation per capita by Jurisdiction



Source: Department of Natural Resources, 2007
(http://www.nr.gov.nl.ca/energyplan/EnergyReport.pdf)

Fossil Fuel Dependence:

Newfoundland and Labrador is dependent on fossil fuels in two primary and related ways: (1) for the provision of electricity, and (2) economically.

Provision of Electricity:

While the province gets approximately 65% of its energy from hydroelectricity (Fisher, Iqbal & Fisher, 2009), a considerable body of research suggests that large-scale hydroelectric developments have significant ecological impacts and associated global warming emissions (Jackson & Barber, 2016; Rosenberg, Bodaly & Usher, 1995). The province is currently constructing the Lower Churchill Project – an 824MW hydroelectric generating facility at Muskrat Falls on the lower Churchill River in Labrador (Nalcor, n.d.). Indigenous organizations have criticized the project for its potential negative environmental effects such as methyl mercury contamination, effects on wildlife and fish populations, and disruption of traditional indigenous lifestyles (Nunatsiavut Government, 2016). While Nalcor Energy (2016) states "Muskrat Falls is clean power, meaning our province will produce 98% clean, renewable energy and will displace the oil burning Holyrood facility", a recent consultant report contradicts this when they state "Liberty expects that new [energy] supply will be needed before Muskrat Falls is in service, to mitigate near-term supply issues and after Muskrat Falls is in service, to mitigate the impact of extended outages of the Labrador-Island link" (CBC News, 2016).

At present, a considerable portion of electricity is provided by fossil fuel combustion. For example, the Holyrood Thermal Generating Station, a heavy-oil fired, steam cycle generating plant, has a total generating capacity of 490MW; the plant provides 15-25% of the province's annual energy needs, rising to 30% during periods of peak demand (DNR, 2012). When operating at full capacity, the plant burns approximately 18,000 barrels of oil per day. Between the years of 2000 and 2010, the plant emitted an annual average of 1.1 million tonnes of carbon dioxide, and over 11,000 tonnes of sulfur dioxide (DNR, 2012).

The province also has many isolated communities that are not connected to the electricity grid. These communities rely exclusively on diesel-fueled generating systems. There are approximately 25 diesel-plants throughout the province, with a total generating capacity of approximately 55MW. Combined, the province's diesel-plants burn an estimated 15 million litres of diesel fuel annually (Jones, 2010).

The provincial Crown Energy Corporation also owns and operates 100MW of gas turbine plants as part of the Island Interconnected System. This consists of a 50MW gas turbine plant in Stephenville, and an additional 50MW plant in St. John's (Hardwoods). According to NL Hydro (2009), the primary purpose of the gas plants is voltage stability, but the plants also operate during periods of peak electricity demand and in emergency circumstances.

In summary, fossil fuels play a significant role in the provision of electricity in the province. This includes the combustion of fossil fuels at the Holyrood Thermal Generating Station, at diesel-plants within isolated communities, and at multiple gas turbine plants.

Economic Dependence:

The province of NL is fiscally dependent on the production of fossil fuels; for example, the Canadian Association of Petroleum Producers (CAPP) (2010) estimates that the provincial government relies on the oil and gas industry for approximately 31% of their total revenue. Fluctuating oil prices can severely impact the NL economy; every dollar drop in the yearly average price of a barrel of oil costs the provincial government $30 million (Bailey, 2014). For example, in 2016 the provincial government has forecasted a budget deficit of approximately $1.8 billion dollars. Sources suggest “that shortfall is caused almost entirely by a slumping oil economy” (Cochrane, 2015).

Provincial Renewable Energy Potential

NL has vast opportunity for renewable energy development; developing these resources may help address the province’s dependence on fossil fuels for the provision of electricity as well as its fiscal dependence on the production of fossil fuels. The provincial energy strategy states that the province has an estimated 18,000MW of previously developed and identified renewable energy resources (Government of NL, 2007); for comparison, total island forecasted peak energy demand was approximately 1,600MW for 2016, or less than 9% of the renewable energy resources available (NL Hydro, 2014).

Wind energy in particular has significant potential in NL; according to the Canadian

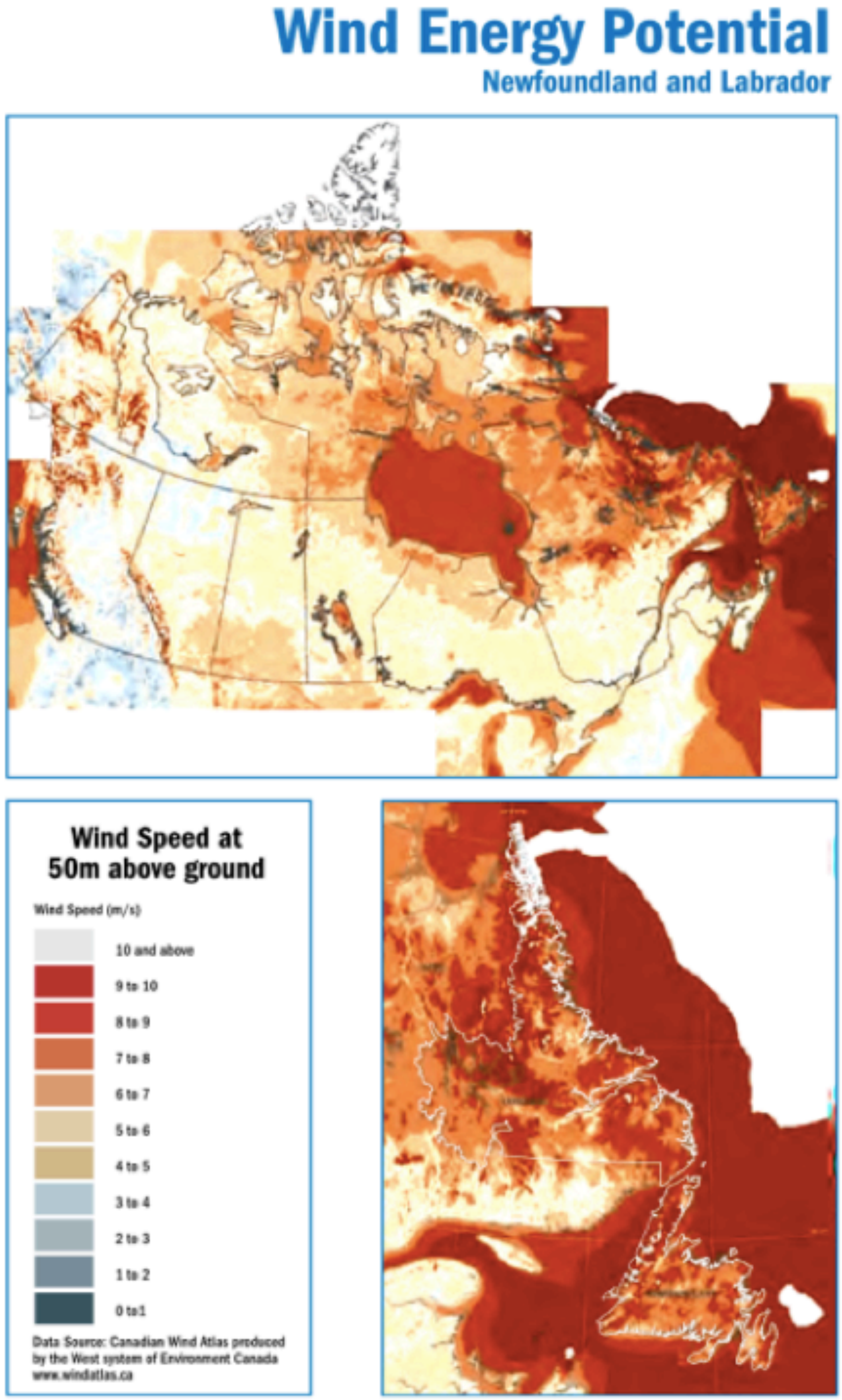
Wind Energy Atlas (2003), the province has amongst the strongest wind energy potential of any jurisdiction in North America **(Figure 1.2).** Fisher, Iqbal, & Fisher (2009) have calculated the total island wind energy potential of Newfoundland as 9.47 x 10^5 gigawatt hours – or approximately 117 times the amount of energy consumed on the island in 2006. This is essentially an estimate of how much energy could be produced if the entire island were converted to a wind farm; demonstrating the significant potential of wind energy development in the province. DNR (2011) estimates that there is 5,000MW of wind energy currently available for development in the province, this is more than three times greater than the amount of energy consumed during peak demand on the island system. Developing small-scale wind projects has great potential in NL as well – Fisher, Iqbal, & Fisher (2006) estimate that up to 440MW of small-scale energy sources could be integrated into the current island system, the researchers suggest small-scale energy sources could replace thermal-energy generation in the province.

Despite the significant potential for wind energy development in the province, development to date has been limited. The provincial energy corporation currently holds power purchase agreements for 54MW of wind energy; one utility-scale wind farm is located in St. Lawrence (27MW) and the other in Fermeuse (27MW) (NL Hydro, n.d.). The Crown Energy Corporation also operates a 300kw wind-hydrogen-diesel pilot project in the community of Ramea, an island on the provinces southwest coast. NL is ranked last among Canada's provinces', and is only slightly above the country's territories, in installed wind energy capacity – the province's 55MW exceeds only that of the Northwest Territories (9.2MW) and Yukon (0.9MW) (CWEA, 2015) **(Table 1.2).**

Ontario	4,361 MW
Quebec	3,262 MW
Alberta	1,500 MW
Nova Scotia	552 MW
British Columbia	489 MW
New Brunswick	294 MW
Manitoba	258 MW
Saskatchewan	221 MW
Prince Edward Island	204 MW
Newfoundland and Labrador	**55 MW**
Northwest Territories	9.2 MW
Yukon Territory	0.9 MW
Total Canadian Installed Capacity	**11,205 MW**

Table 1.2: Installed Wind Energy Capacity by Canadian Province

Figure 1.2: Wind Energy Potential in Newfoundland and Labrador



The thesis will demonstrate that energy transition in NL is a complex and difficult process often impeded by several individual and interrelated barriers with economic, educational, legislative, and technological components. Overcoming these barriers requires a province-wide awareness that the transition is needed and practical steps by the provincial government (develop an energy transition policy and relevant legislation) and the civil society (academic programs to prepare the labor force and provide technological solutions; entrepreneurs willing to invest in wind energy; communities ready to accept wind turbines, etc.) in order to start implementing the transition.

The complex environmental issue under study in the current project is the energy system of Newfoundland and Labrador. The project will identify barriers to energy transition in the province based on Trudgill's (1990) 'AKTESP' (agreement, knowledge, technological, economic, social, and political related issues) framework for analysis. Based on the barriers identified, a comprehensive policy framework will be presented which encourages energy transition and the development of a viable wind energy industry in the province of Newfoundland and Labrador.

1.5: Research Objectives

The research objectives for the current study are as follows:

1) To apply a case-study approach – concentrating on Newfoundland and Labrador - which enables an understanding of the complex barriers to renewable energy development (with a focus on wind energy) in a provincial context.
2) To implement Trudgill's (1990) 'AKTESP' (agreement, knowledge, technological, economic, social, and political barriers) framework for analysis in order to organize and analyze empirical evidence and to guide the discussion of barriers to wind energy development and possible solutions.
3) To develop a region-specific policy framework consisting of recommendations which will help in addressing barriers to renewable wind energy development in Newfoundland and Labrador.
4) To conduct an exploratory study which identifies critical areas of future research in Newfoundland and Labrador energy policy.

1.6: Research Questions

The central research question of the current study is:

1) Adhering to Trudgill's 'AKTESP' framework for analysis, what are the most significant barriers (agreement, knowledge, technological, economic, social, and/or political) to wind energy, as well as disadvantages in a provincial context, and how do they interact to inhibit energy development in Newfoundland and Labrador?

Secondary research questions include:

2) What are the primary benefits of wind energy development in a provincial context?
3) Based on the barriers identified in the study, which policy measures would encourage the development of a viable wind energy industry in the province?

1.7: Overview of Thesis

The thesis is organized as follows:

Chapter Two provides a critical analysis of relevant literature on barriers to renewable energy development. Literature related to agreement, knowledge, technological, economic, social and political issues which affect renewable energy development is critically examined; based on the results of the literature review, a knowledge gap is established.

Chapter Three provides an overview of the research methodology as well as the specific research methods. This includes a discussion of the theoretical framework, applied analytical framework, data collection and analysis techniques, as well as ethical implications of the study.

Chapter Four delivers an in-depth analysis of the research findings – this includes a presentation of what participants perceived as the most significant barriers to wind energy development in NL, as well as what they thought to be the primary opportunities for wind energy development.

Chapter Five provides a discussion of significant research findings. The findings of the study are used to establish an 'Energy Transition Framework' for the province consisting of seven key policy recommendations. Implications for theory and practice are also discussed.

Chapter Six is a conclusion of the study. This chapter recaps the significance of the problem, provides a synthesis of the research findings, an overview of the 'Energy Transition Framework' for NL, and recommendations for future research.

Chapter Two: Literature Review

2.1: Introduction

The current thesis is intended to demonstrate that energy transition in Newfoundland and Labrador (NL) is a complex and difficult process – impeded by several individual and interrelated barriers. Due to the inherent complexity of the thesis topic – the following literature review is wide ranging in scope, examining numerous peer-reviewed articles, published books, and government documents which are pertinent to the topic. Furthermore, the field of environmental and energy policy is interdisciplinary in nature, therefore the current research draws on a number of disciplines including policy analysis, environmental science, environmental law, engineering, economics, political science, social psychology, among many others. Drawing on all of these disciplines will allow an informed picture to emerge of the various obstacles to renewable energy development. While the literature review focuses broadly on barriers to the implementation of all renewable energy sources – an effort is made to provide literature on barriers specific to wind energy development.

The following literature review and research project are organized according to Trudgill's (1990) 'AKTESP' (agreement, knowledge, technological, economic, social, and political) framework for analysis – the AKTESP framework is explored it greater detail in the methodology chapter; this should not be considered an exhaustive overview of all barriers to renewable energy development, instead it should be seen as a critical analysis of the major themes identified in the relevant literature affecting the transition to renewable sources of energy. A growing number of researchers have implemented the AKTESP framework in their investigations of barriers to achieving a better environment: examples include public resistance to solar energy (Haw et al, 2009), the implementation of cumulative effects assessment (Piper, 2001), the conservation of cultural landscapes (Selman, 2004), as well as the development of large-scale wind energy on a regional scale (Richards, Noble, & Belcher, 2012). The widespread use of the AKTESP Framework illustrates its applicability to diverse environmental challenges. For each category of the AKTESP framework, general barriers to renewable energy development are presented – followed by more specific barriers to wind energy development in particular.

2.2: Agreement Barriers to Renewable Energy Development

2.2.1: The Scientific Consensus on Climate Change

The available scientific literature largely supports the consensus that anthropocentric global warming is occurring. For example, the IPCC (2007) – the world's leading international body for the assessment of climate change related literature – concluded, that since 2007 "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (p.2). Furthermore, the IPCC report concluded that "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropocentric greenhouse gas [GHG] concentrations" (p.5). In the IPCC most recent report (2014) it is stated "it is extremely likely (meaning 95-100% certainty) that human influence has been the dominant cause of the observed warming since the mid-20th century" (p. 16).

2.2.2: Climate Change Denial and Support for Climate Policy

Since the early 1990s, a well-documented and organized climate change denial movement has mobilized in North America to undercut public belief in climate science and political support for climate policy (Dunlap & McCright, 2011; Oreskes & Conway, 2010; Powell, 2011). The denial movement challenges the scientific community's claim that anthropocentric global warming is occurring, and that it produces harmful impacts to humans and ecosystems. The movement challenges the scientific consensus by amplifying views of contrarian scientists and generating petitions asserting the lack of consensus (Hoggan, 2009), a strategy encouraged by the media's tendency to present a "balanced" view in its coverage of climate policy by highlighting dissenting opinions (Boykoff, 2011). The sustained climate change denial movement contributes to political polarization on climate change beliefs and concern in the USA (Hamilton, 2011; Malka et al, 2009; McCright and Dunlap, 2011).

A relatively recent study (Ding et al, 2011) using nationally representative survey data from 2010 found that misperception of scientific agreement on climate change is associated with lower levels of support for climate policy and beliefs that action should be taken to deal with global warming. The authors found that misperception of scientific agreement is the critical factor reducing support for climate policy, and that this relationship is mediated by beliefs about the timing, cause, and impacts of global warming.

2.2.5: Disagreement Among Experts & Biased Information Processing

Wilson and Anderson (2006) explain how disagreements among experts can represent a barrier to environmental solutions. The authors cite the example of the Environmental Protection Agency's (EPA) Clean Air Science Advisory Committee - and their established panel of experts on ozone. The panel ultimately agreed that they could not clearly establish that any of their expert stances were "significantly more protective of public health" than the others. The expert panel concluded that setting the standard was purely a policy choice, because they could not reach consensus on which scientific evidence was most pertinent to the issue. Despite this – more than half of the panel offered the EPA their various and conflicting personal opinions as to where emissions standards would be set. The policymakers promoted whichever personal opinions agreed with their own and cited them as scientific fact – causing a perpetual disagreement on an environmental solution, where all sides were 'grounded in scientific evidence' (Wilson & Anderson, 2006).

The academic literature suggests that conflicting scientific evidence may cause arbitrary defense of a stakeholder's position. A study conducted by Teel et al (2006) demonstrates the effects of biased processing of information in natural resource management. In their study, the authors evaluate the opinions of undergraduate students towards oil drilling in the Arctic National Wildlife Refuge. Students who identified as anti-drilling were highly critical of science supporting drilling, while supportive of science that was anti-drilling. Likewise, students who identified as pro-drilling were highly critical of science that is anti-drilling, and supportive of science that was pro-drilling. The study demonstrates the effects of biased information processing; and that individuals will accept scientific evidence which is supportive of their own views, and discount evidence that is contrary to their beliefs.

The literature presented here on expert disagreement and biased information processing is well established within various disciplines (Lord, Ross, & Lepper, 1979; Mahoney, 1977; Vallone, Ross, & Lepper, 1985). While the majority of these publications are foundational studies within the field of social psychology – the implications for environmental and natural resource management are clear (Teel et al, 2006). Despite the scientific consensus on climate change and the growing body of literature in support of renewable energy technology (for example: Sastresa et al, 2010; Machol & Rizk, 2013) - the realities of biased information processing and expert disagreement continue to represent a barrier to renewable energy development.

2.2.6: Lack of Utility Acceptance

'Lack of utility acceptance' is an often cited idea within energy policy literature (see Beck & Martinot, 2004; Caris, Haffar, Jones, & Morey, 2010; Heymann & Barrera, 2013;

Zillman, 2008). Proven, cost-effective technologies may still be perceived as risky if there is little experience with them in a new application or region. The lack of visible installations and familiarity with renewable energy technologies (RET) can lead to perceptions of greater technical risk than that for conventional sources of energy. Beck & Martinot (2010) explain how these perceptions may increase required rates of return, result in less capital availability, or place more stringent requirements on technology selection and resource assessment. "Lack of utility acceptance" is the term used to describe the historical biases and prejudices on the part of traditional electric power utilities. Utilities may be hesitant to pursue, acquire, and maintain unfamiliar RE technologies, or give them proper attention in planning frameworks.

It has been suggested that this prejudice may exist because of poor past performance of RET that is out of step with current performance norms (Beck & Marinot, 2004). Specific to wind-diesel energy systems, lack of utility acceptance is often attributed either to failed historic projects, or the next barrier identified as the difficulty of dispatching or controlling the output of wind energy systems into the existing utility infrastructure. This can be either a perceived or a real limit due to the lack of availability or high cost of technologies that overcome this problem (such as energy storage technologies) (Heymann & Barrera, 2013).

'Lack of utility acceptance' is often cited as a significant barrier to renewable energy development in the existing literature; despite this, the literature available to date is largely theoretical and is currently unsupported by peer-reviewed empirical evidence. For example, Zillman (2008) reports that renewable energy developments often have trouble obtaining regulatory approval due to 'lack of familiarity with such installations from officials and authorities'. The evidence provided by Zillman includes a single news article on wind energy development in Australia, and a policy report on promoting renewable energy. While much of the anecdotal evidence suggests that 'lack of utility acceptance' is occurring – it is important to note that it has been speculative or theoretical in nature.

2.3.: Knowledge Barriers to Renewable Energy Development

2.3.1: Consideration of Scientific Uncertainty in Decision-Making

A broader knowledge barrier identified in the relevant literature is the incorporation, or lack thereof, of scientific uncertainty into decision-making. Researchers argue that the inaccurate translation from scientific information into effective government policy can sometimes be attributed to the improper inference of scientific uncertainty (Bradshaw & Borchers, 2000). The authors explain that while scientists are typically familiar with scientific uncertainty – the public and decision-makers often seek certainty and deterministic solutions. For example, scientific simulation models employ assumptions that are characterized by uncertainty. This is business as usual for scientists, but 'uncertainty' can often cast doubts over scientific results for decision makers and the public.

The Rio Declaration provides a useful definition of the precautionary principle. "Nations shall use the precautionary approach to protect the environment. Where there are threats of serious or irreversible damage, scientific uncertainty shall not be used to postpone cost-effective measures to prevent environmental degradation" (United Nations, 1992). While scientists can use results from simulation models to promote environmental action based on the precautionary principle, decision makers and the public can reject the same findings based on uncertainly and allow environmental degradation to continue (Bradshaw & Borchers, 2000). Ignorance and inappropriate use of scientific uncertainty could potentially represent a barrier to renewable energy development – if decision makers are presented with scientific information in favour of transition to carbon-neutral sources of energy, this science may be rejected based on the uncertainty of scientific models.

2.3.2: Lack of Awareness and Information Regarding Renewable Energy Costs and Benefits

A growing body of literature has supported the idea that a lack of awareness and information of the costs and benefits of renewable energy technologies has prevented their diffusion into energy systems (Reddy & Painuly, 2004; Luthra et al, 2015; Richards, Noble, & Belcher, 2012). Households, small firms, and commercial operations face difficulties in obtaining information about renewable energy technologies compared to the simplicity of buying conventional energy sources (Reddy & Painuly, 2004). A lack of adequate awareness about costs and benefits of renewable energy technologies among stakeholders may result in a lack of interest and commitment to promote them (Luthra et al, 2015).

For example, researchers found that contradictory knowledge about the benefits of wind energy was a barrier to further development of the resource in the Canadian province of Saskatchewan (Richards, Noble, & Belcher, 2012). Some participants in their study stated that wind energy generation was not possible below -30°C, while other participants stated that the wind turbines could in fact operate in even colder temperatures. The authors state "this example was illustrative of disagreement amongst stakeholders about questions that have objective answers" (p. 694). Such discrepancies are usually the result of misinformation, miscommunication, or misunderstanding and can hinder the advancement of renewable energy sources (Richards, Noble, & Belcher, 2012).

2.3.3: Lack of Higher Education Regarding Renewable Energy in General and RE Technology in Particular

Researchers have concluded that many energy professionals lack formal training in the skills and disciplines needed to undertake work on renewable energy systems and energy management (Jennings & Lund, 2001). Without qualified employees to work in the industry, the renewable energy industry cannot flourish. For instance, the European Union International Labour Organization (ILO) (2011) concludes "The shortage of green-collar professionals with cutting-edge skills in energy efficiency, green engineering, and green construction has already been identified in a number of countries as a major obstacle in implementing national strategies to cut greenhouse gas emissions".

The Foundation Biodiversity (2010) stated that the general shortage of engineers in Europe and in many countries, affects the renewable energy sector. Specialists in technical aspects of various renewable technologies (solar, wind, geothermal, bioenergy, and hydropower) are needed. There is also a significant need for qualified design engineers (civil, mechanical, and electrical) with specific knowledge in renewable energy technologies. Furthermore, the Foundation presented a survey of bioenergy companies in Australia, where over 85% indicated that there was currently a lack of suitably skilled engineers in the industry.

Studies suggest that the level of training for workers in renewable energy is higher than for other sectors of the economy. For example, in Spain 50% of the renewable energy sector's employees have university studies and 29% have vocational education and training, in comparison with 23.5% university studies and 18.6% vocational training graduates for the rest of the Spanish economy (Foundation Biodiversity, 2010).

These conclusions are complementary to the larger literature which stresses the importance of education in achieving ecologically sustainable development (ESD). For instance, The World Commission on Environment and Development (1987) emphasized the importance of teachers and education for ESD by saying: "the world's teachers have a crucial role to play (in helping to bring about) the extensive social changes (needed for

ESD) (p. xiv). The International Union for Conservation of Nature (IUCN) (1992) stresses the importance of changing attitudes through education:

> "Sustainable living must be the new pattern for all levels, individuals, communities, nations and the world. To adopt the new pattern will require a significant change in the attitudes and practices of many people. We will need to ensure that education programs reflect the importance of an ethic for living sustainably" (p.5).

Agenda 21, an action plan approved by the United Nations regarding sustainable development, calls on all nations to develop and implement national strategies for ESD and notes that scientific and technological education in the past have been too narrowly-focused. Agenda 21 advocates a change of approach to meet the needs of ESD and suggests that all students and teachers should be exposed to the concepts and methods of ESD as part of their formal education (United Nations Conference on Environment and Development [UNCED], 1992). More recently, world leaders at the United Nations adopted the *'2030 Agenda for Sustainable Development',* which encompasses 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change (United Nations Development Programme [UNDP], 2015); SDG 4 goal is entitled 'Quality Education', aiming more specifically, to 'insure inclusive and equitable quality education and promote lifelong learning opportunities for all' (para. 2). The UNDP agenda states 'achieving inclusive and quality education for all reaffirms the belief that education is one of the most powerful and proven vehicles for sustainable development' (para. 5).

2.3.4: Wind Energy Engineering Challenges

According to Thresher, Schreck, Robinson, and Veers (2008) wind energy technology has matured to a point where it is now difficult to sustain a rapid rate of improvement without major advancements in the fundamental understanding of the basic physical processes underlying wind energy science and engineering. The authors conclude that "there are fundamental knowledge barriers to further progress in virtually all aspects of wind energy engineering" (p.8). The principal knowledge barriers identified by the researchers include the fundamental understanding of: atmospheric flows, unsteady aerodynamics and stall, turbine dynamics and stability, turbine wake flows and related array effects, and even climate effects caused by the large-scale use of wind energy (Thresher et al, 2008).

2.4: Technological Barriers to Renewable Energy Development

2.4.1: The Current State of Wind Energy Technology

Wind energy technology has a long history in Canada – wind energy was first used for agricultural and domestic purposes dating back to the 1600's, and small windmills were used to produce electricity in the early 1900's (Rangi, Templin, Carpentier, & Argue, 1992). Wind energy technology has developed rapidly since, and is now considered technologically mature – according to Rangi et al (1992):

> “wind turbine technology has reached a mature status in the past decade as a result of international commercial competition, mass production and continuing technical success in R&D. The earlier concerns that wind turbines were expensive and unreliable have been largely allayed” (1992, p.v.).

Wind energy’s technical maturity is demonstrated by its current global installed capacity and rapid growth as a source of energy. For instance, total installed wind energy capacity increased from just 2,000MW in 1990 to 369,000MW in 2014 (Rangi et al, 1992; Global Wind Energy Council [GWEC], 2015). Wind energy currently supplies approximately 3.1% of the total global power supply (Renewable Energy Network [REN], 2015). Global leaders in cumulative installed wind energy capacity include China (143,642MW), USA (74,471MW), Germany (44,947MW), India (25,088MW), and Spain (23,025MW) (GWEC, 2015). Leaders in wind energy as a share of their overall electricity generation include Denmark (39%), Portugal, Spain, and Ireland (20% each) (Statista, 2014). Canada’s current installed wind energy capacity is approximately 11,000MW – or an estimated five percent of total electricity supply (CWEA, 2015). Despite the advances and the maturity of wind turbine technology, there are still a number of technological limitations which have inhibited wind energy’s wide-spread adoption as a source of energy: the most common technological barriers cited include the effects of intermittency, as well as energy storage.

2.4.2: Intermittency of Renewable Energy Sources

One of the more common debates between proponents and critics of wind power has to do with the impacts of intermittency or wind variability. Rangi et al. (1992) define wind energy as 'the conversion of kinetic energy from a moving stream of atmospheric air into mechanical energy or electricity'. Due to the fact that atmospheric air – wind - does not blow all the time, the energy available from wind is characterized as intermittent. Wind speeds are highly variable, and will, on occasion, be small or even zero during periods of high energy demand. Critics of wind energy argue that wind power's intermittency precludes its use on a large scale – because electricity from wind power is not always available when needed (Musgrove, 2012). Wind's variability can create added expenses and complexity in balancing the supply and demand of energy on the grid.

Due to the intermittency of wind, wind plants cannot operate as base-load units (i.e., they do not continuously operate). Electric power systems must be able to meet consumer demand at all times. For this reason, power systems are built around generating technologies that are dispatchable and predictable. Wind turbines and other variable renewable sources are weather dependent; therefore, they cannot achieve the same degree of reliability or continuous operation as fossil fuel or nuclear technology. For example, a typical nuclear facility has a capacity factor (i.e.: rate of continuous operation) of nearly 90%, coal plants average 70%, and wind farms range from 20-40% (Logan & Kaplan, 2009). According to Milligan et al (2006), when wind energy constitutes 10-15 per cent of a system's total energy capacity, the system must incur additional costs to provide a reliable backup for the wind turbines; additional costs come in the form of contingency reserve requirements, increased maintenance on the existing system, etc. (National Renewable Energy Laboratory [NREL], 2014). Estimates for these integration costs range from USD $1.85 - $4.97 per megawatthour (Milligan et al, 2006).

While wind's variability does create added expenses and complexity – it is important to note that these integration costs do not become significant (5-10% of wholesale prices) until wind energy accounts for 15-30% of the capacity in a given system (Logan & Kaplan, 2009). Lynn (2012) concludes "That there are no insuperable technical problems, at least up to penetration levels of 20%, seems proven by the experience of pioneering countries that are already integrating substantial amounts of wind energy into their grid networks" (p.194). The costs of wind integration with penetration levels of up to 30% are well below US $.01/kWh and are typically below $.005/kWh (Wiser & Bolinger, 2008).

Musgrove (2012) counters the intermittency argument; claiming that despite wind's variability and even with low wind energy penetration levels – the technology still achieves its objective of displacing the consumption of fossil fuels, improving energy security, and delivering substantial reductions in greenhouse gas emissions. For example, wind turbines can displace the consumption of fossil fuels at conventional plants during windy periods – and thermal plants can provide energy during windless periods. A single

1,000MW wind farm would reduce UK coal consumption by 1.5 million tonnes per year, and eliminate emissions of 4 million tonnes of carbon dioxide (CO_2) per year.

A greater geographic dispersion of variable energy sources has been promoted as a solution to intermittency in the relevant literature (Drake & Hubacek, 2007; DeCarolis & Keith, 2006; Holttinen, 2005). If wind speeds drop at one location, typically they will remain strong or pick up in other locations – therefore, spatially dispersing wind farms helps to overcome vulnerabilities associated with wind variability. The findings of Drake & Hubacek (2008) conclude that geographically dispersing wind farms can reduce wind power variability by 36%. Furthermore, Holttinen (2005) discovered that errors in predicting wind power fell by 9% if predictions were made for Denmark as a whole as opposed to making separate predictions for East and West Denmark. While spatially dispersing wind farms is a simple solution to addressing variability – it can come at high cost. For example, DeCarolis and Keith (2006) found that dispersing wind farms in the previous Denmark example only becomes economically viable with a carbon price of $300 per tonne – which is currently unrealistic for this European country.

2.4.3: Energy Storage

Energy storage has been promoted as a way to overcome the challenges of variable renewable sources, such as wind power. The principle is that as variable energy sources produce excess energy during periods of low demand, it can be stored in one form or another for consumption at a later time. There are many different forms of energy storage technologies at different stages of commercial development; the most common forms of energy storage cited in the literature include hydrogen pumped storage (HPS), compressed air energy storage (CAES), and advanced batteries (Logan & Kaplan, 2009).

HPS is the most widely used form of energy storage – accounting for 99% of worldwide storage capacity, or approximately 127,000MW of discharge power (Dunn, Kamath, & Tarascon, 2011). During periods of high winds and low energy demand, excess turbine output can be used to pump water into a reservoir at a higher elevation. The water can be released through a hydroelectric generator when the power is needed into a lower reservoir. According to Diaz-Gonzalez, Sumper, Gomis-Bellment, and Villafafila-Robles (2012) HPS has significant potential globally; for type-one HPS the potential is 1,675 gigawatts (GW) – and for type-two HPS the potential is 1,454 GW.

Another form of energy storage is CAES. The operating principle behind this technology is similar to that of HPS - but instead of pumping water from a lower to higher reservoir, in a CAES plant, ambient air is compressed and stored in an underground cavern. When electricity is required, the pressurized air is heated and expanded in an expansion turbine driving a generator for power production (Energy Storage Association, 2016). Currently, the use of CAES is limited - only two plants have been constructed globally; one in Germany (290MW) and the other one in the USA (110MW) (Diaz-Gonzalez et al, 2012).

Battery technology refers to storing energy in the form of electrochemical energy. Many types of batteries are mature technologies, and research involving Lead-Acid batteries has been conducted for over 140 years (Diaz-Gonzalez et al, 2012). For example, sodium/sulfur battery technology is commercially available for grid applications, with 200 installations worldwide, or 315MW of discharge capacity (Dunn, Kamath, Tarscon, 2011). A significant effort is being made to turn technologies such as nickel-cadmium and lithium-ion batteries into cost effective options for higher power applications.

While many energy storage technology options are under development, Logan and Kaplan (2009) conclude that "most energy storage options are expensive and still under development" (p.12). Currently, these technologies face technical hurdles and high costs. Logan and Kaplan (2009) state: "a technological breakthrough in one of these storage options could enhance the ability of wind energy to supply large quantities of electricity on demand, but whether such breakthroughs are forthcoming is unpredictable" (p.13).

2.5: Economic Barriers to Renewable Energy Development

2.5.1: Cost Competitiveness of Wind Energy

According to Ackermann and Soder (2002), a general comparison of electricity production costs is difficult – as production costs vary greatly between countries, due to the availability of resources, country's level of development, different tax structures, and other reasons. However, the levelized cost of electricity (LCOE) is a widely used tool for comparing the costs of electricity production by different sources (NREL, 2011). LCOE accounts for the present value of a power system's expected lifetime costs – including financing, maintenance, and operation - which are then divided by the systems expected lifetime power output.

According to this metric, wind energy is becoming increasingly cost competitive with other forms of energy production. For example, between the years 1980 and 2000 the LCOE of wind power declined by a factor of more than three, from more than $150 per megawatt hour (MWh) to approximately $50/MWh (NREL, 2012). During this time period, wind power installation costs have fallen by more than 65% in the United States and 55% in Denmark. The NREL (2012) predicts that on a global basis, the cost of wind energy will continue to decrease; for results that fall between the 20th and 80th percentile of price reduction scenarios, the price of wind energy is expected to fall between 20-30% by 2030.

According to data collected by the IEA (2015), wind energy plants are cost competitive with other energy sources according to the LCOE metric. On average, onshore wind energy is expected to cost $73.6/MWh in 2020; this is compared to $75.2/MWh for conventional combined cycle (natural gas), $95.1 for conventional coal, and $95.2 for advanced nuclear. Costs of other renewable energy technologies in 2020 range widely including geothermal at $47.8/MWh, hydroelectricity at $83.5, solar photovoltaic (PV) at $125.3, and offshore wind at $196.9.

Some authors have criticized LCOE models for comparing energy sources (Ueckerdt, Hirth, Luderer, & Edenhofer, 2013). These authors argue that LCOE is inappropriate because it does not incorporate the integration costs of variable renewable sources. Instead the authors propose a model called System LCOE which includes the costs of energy storage, transmission expansion, and other integration costs. While the researchers concede that these additional costs do not become significant until variable sources account for 20% of energy in a given system – they do demonstrate that beyond 20% penetration levels, costs escalate quickly. For example, the researchers found that reaching 40% wind penetration levels would add an additional 60 €/MWh – effectively doubling the cost of wind energy installation.

Some researchers have criticized LCOE projections (Stacy & Taylor, 2015) because they only compare the costs of newly built generation sources – and ignore the costs of producing electricity at existing facilities. Existing energy plants no longer have certain costs such as construction and financing – only ongoing operational and maintenance costs, which typically makes them cheaper than newly built energy sources. According to the researchers' calculations, existing coal facilities produce electricity at a cost of $38.4/MWh, existing combined cycle (natural gas) at $48.9/MWh, existing nuclear at $29.6/MWh, and existing hydro at $34.2/MWh (compared to $50/MWh for wind as noted above).

2.5.2: Economic Externalities

The economic externalities of fossil fuel use are considered a key market barrier to the penetration of renewable energy sources (Owen, 2006; Machol & Rizk, 2013). The OECD (2003) defines an externality as “when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided”. Pollution is a clear example of a negative externality – while consumers may pay a certain price for electricity from a fossil fuel plant, they typically do not pay for the associated health or environmental impacts from the plant’s emissions. Incorporating the external costs of fossil fuels into their retail price would make renewable energy technologies more cost-competitive with alternatives.

For example, Machol and Rizk (2013) suggest that the cost of poor air-quality caused health impacts from fossil fuel electricity in the United Sates is USD $361.7-886.5 billion per year, or approximately 2.5-6.0% of the national gross domestic product (GDP). The estimates include valuation of premature mortality, workdays lost, and direct costs to the healthcare system associated with the direct emission of particulate matter, nitrous oxide, and sulfur dioxide from thermal-generating stations. Nationally, they suggest that the average economic health impact associated with fossil fuel usage is $0.14-$0.35 per kWh. For coal the health impacts are $0.19-$0.45/kWh, for oil the costs are $0.08-$0.19/kWh, and for natural gas the cost range is $0.01-$0.02/kWh. The authors conclude that for both coal and oil, the economic value of their health impacts is greater than the typical retail price of each commodity.

The EPA in the United States, as well as other federal agencies, use the 'social cost of carbon' (SCC) in policymaking and planning exercises. The SCC reflects the price society pays for changes in agricultural output, impacts on human health, and property damages from increased flooding, and other associated byproducts of climate change. The current price used by the EPA is approximately $37/ton of carbon emitted (2015). The social cost of carbon, as calculated by Environment Canada in 2013, is $28.15/ton CO2 e (Sustainable Prosperity, 2015). More recent research has suggested that the price of economic damage from carbon dioxide emissions globally is roughly $220/ton – or nearly six times higher than the figure used by the U.S. government (Moore & Diaz, 2015); the researchers acknowledge that poorer countries are more vulnerable to the effects of climate change, and this may affect the price of carbon emissions in these regions.

Other researchers assert that virtually all forms of energy production have externalities. For example, the European Commission (1995) developed a widely used methodology called ExternE, which calculates the external costs of energy generation by source; this framework shows that wind energy has important economic externalities such as impacts on noise, visual amenity, atmospheric emissions, and employee accidents. Moderate externalities of wind energy include impacts on bird populations, terrestrial ecosystems, and interference with electromagnetic communication systems. While renewable energy technologies do have externalities, they are generally much less significant than fossil fuel sources; for example, in Denmark, wind energy externalities in € cent per kWh were calculated as 0.05, for solar PV were 0.6, for natural gas were 1-2, for coal 3-6, and for oil were 5-8 (European Commission, n.d.).

2.5.3: Fossil Fuel Subsidies

The World Economic Forum [WEF] defines an energy subsidy as "any government action that lowers the cost of energy production, raises revenues of energy producers, or lowers the price paid by energy consumers" (2013, p.1). The IEA (2014) estimates that in 2013 the fossil fuel sector received $548 billion in subsidies, compared to only $121 billion for the renewable energy sector. Numerous researchers argue that a high level of fossil fuel subsidies creates an economic disadvantage for the development of renewable energy sources (International Institute for Sustainable Development [IISD], 2014; Whitley & van der Burg, 2015; Ouyang & Lin, 2014).

The IISD (2014) argues that fossil fuel subsidies inhibit renewable energy development in three primary ways: reducing cost competitiveness of renewables, supporting incumbent generation sources – which increases entry barriers for renewables, and inhibiting investment in renewable sources. A recent study on barriers to renewable energy development in Pakistan concluded that if fossil fuel subsidies were removed and environmental externalities taken into account, renewable resources were likely to have comparable or lower costs than fossil fuels (Mizra, Ahmad, Harijan, Majeed, 2009).

Other researchers and organizations examine the important role fossil fuel subsidies have played in supporting vulnerable populations by improving access to electricity, stimulating regional economic development, supporting small and medium sized enterprises – as well as energy intensive industries, and promoting energy security (European Energy Association [EEA], 2004). The IISD (2013) counters that these might have been desirable benefits from fossil fuel subsidies previously, but all of these arguments can now be used to support the development of low-impact renewable resources today.

2.6: Social Barriers to Renewable Energy Development

A large number of academic researchers have concluded that public, and often local, opposition is a key barrier to the development of renewable energy sources (Moula et al, 2013; Batel, Devine-Wright, & Tangeland, 2013). This is particularly true for the development of wind energy – the U.S. Department of Energy (2009) reports that between 10-25% of wind energy projects are not built, or are significantly delayed, because of local environmental concerns. Lantz & Flowers (2010) argue that the economic viability and the technological capabilities of wind energy are no longer the main barrier to implementation – increasingly, community acceptance is becoming the key challenge. Some of the more prominent themes in the relevant community acceptance literature concentrate on the phenomena of Not In My Back Yard-ism (NIMBYism), wind energy's impacts on public health, and wind energy's ecological or wildlife impacts

– this is not to say that other factors are not important, but they are not the focus of the current investigation. A brief analysis of this literature is provided below.

2.6.1: NIMBYism

Individuals who generally have positive attitudes towards wind energy – often have differing opinions when wind energy development takes place in their immediate vicinity; this phenomenon has been referred to as NIMBYism (Wizelius, 2007). Wolsink, as cited in Wizelius (2007), describes four categories of NIMBY attitudes:

A) Positive attitudes towards wind installations generally, but negative attitudes when installations are in their immediate vicinity.

B) Generally negative attitudes towards wind energy.

C) Positive attitudes towards plans to develop wind power, which change when there are plans to install wind turbines within their vicinity.

D) Negative attitudes towards planning procedures rather than to wind power.

Wizelius (2007) suggests that NIMBYism is measurable in terms of positive and negative attitudes towards renewable energy development; and that a general NIMBY curve throughout the life of a wind project reflects generally high positive attitudes at the beginning of projects (75% positive), reduced positive attitudes during the planning phases of the project as concerns such as wind turbine noise, shadow flicker (the effect of flickering shadows from spinning turbine blades), and distance to homes are prevalent

(60% positive), and eventual return to high positive attitudes once wind turbines are installed and operating (75% or even slightly higher).

Eggergluss, as cited in Wizelius (2007) demonstrates that most people accept wind turbines if project developers adhere to the following principles: turbines are a sufficient distance from residential areas; quiet turbines are installed; the local population is kept properly informed of the project; there is a financial benefit for the community; the developers are from the local area; and landowners' input is properly considered in the selection of installation sites.

Criticism of NIMBYism exists in the academic literature. For example, Wolsink (2000) defines NIMBYism as "people that combine a positive attitude and resistance motivated by calculated personal costs and benefits" (p.53). Despite the technical nature of the phenomenon, many authors use the term without an explicit definition – simply equating NIMBYism with local opposition. The existing literature shows that it is difficult to find individuals who are in favour of renewable energy – but are motivated by personal calculated costs and benefits to oppose local developments (Wolsink, 2000; Bell et al., 2013). According to Burningham, Barnett, and Walker (2015) "the term is a pejorative shorthand to denote irrational, selfish, and obstructive individuals who fear change and stand in the way of essential developments" (p. 247). More recently, scholars have been trying to provide more sophisticated understandings of why individuals support and oppose the siting of renewable energy facilities (Devine-Wright, 2011).

2.6.2: Public Health Impacts of Wind Turbine Exposure

The growth of wind turbines in sheer number and size has led to questions about the effects of wind energy on public health – researchers have identified the perception of turbine-induced health impacts as a major determinant of wind energy opposition (Baxter, Morzaria, & Hirsch, 2013). Opinions exist that two aspects of wind turbines have impacts on public health: 1) wind turbine design and infrastructure (i.e.: electromagnetic frequencies from transmission lines and shadow flicker from rotor blades), and 2) wind turbine noise (infrasound, low-frequency sound, etc.) (Kurpas, Mrozek, Karakiewicz, Kassolik, & Andrzejewski, 2013). The literature on these health impacts is vast (for example Pedersen, 2011; Shepherd, McBride, Welch, Dirks, & Hill, 2011); but, more recently, comprehensive literature reviews have been commissioned by government agencies in order to address public concern over the health effects of wind turbine exposure.

For example, the Council of Canadian Academies (2015) was consulted by the Canadian Government to conduct a comprehensive literature review on the health effects of wind turbine noise [WTN]. The panel identified 30 potential health effects of wind turbine noise in the relevant literature – and concluded that the available evidence can only establish a causal relationship between exposure to wind turbine noise and annoyance. For other often cited health effects, including sleep disturbance and stress, the panel found that there was 'limited evidence', and a 'lack of adequate evidence' for the latter. For the 27 remaining health effects – the panel found that the evidence was 'insufficient to support any conclusion about the presence or absence' of a causal relationship with exposure to WTN.

The Massachusetts Department of Environmental Protection (2012) convened a similar independent panel to conduct a complete analysis on the health effects of exposure to wind turbines – including impacts from noise, infrasound, vibration, and light flicker. The panel found no scientific evidence to support most claims about 'Wind Power Syndrome', infrasound effects, and harm blamed on wind power such as pain and stiffness, diabetes, blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headaches or migraines.

Nevertheless, Baxter, Morzaroa, & Hirsch (2013) report that the perception of health impacts is a significant predictor of levels of community support for wind energy development. This means that mitigation of potential health effects, and communication of risks to residents need to be a priority for wind energy developers – the researchers state "there is enough evidence here to suggest developers, regulators and legislators need to take seriously those who claim their health problems are linked to local turbines" (p. 941).

2.6.3: The Ecological Impacts of Wind Energy

Logan & Kaplan (2009) suggest that community opposition to wind energy is often based on local environmental considerations including concerns surrounding avian and bat mortality. Wind energy causes avian and bat mortality in three primary ways; the first being direct collisions with wind turbines, the second due to air pressure change caused by spinning rotor blades, and the third being the result of habitat fragmentation.

Loss, Will & Mara (2013) provide a mean estimate of bird deaths due to wind turbines in the U.S. as 234,000 per year. Other researchers have calculated bird mortality as a result of wind energy in the U.S. to be much higher - approximately 537,000 per year. The wide range of estimations are due to differences in methodologies – including the search radius around turbines for birds, factoring in carcass removal by predators, or accounting for different types of wind turbine structures. Furthermore, Erickson et al. (2001) completed a meta-analysis of avian collusions studies at wind farms in the U.S. and found that 78% of carcasses were songbirds – which are protected by the Migratory Bird Treaty Act. The available scientific literature shows that wind turbines do cause bird and bat mortality, and this is a legitimate public concern.

Other research acknowledges avian mortality due to wind turbines, but demonstrates that nationally the impacts are relatively modest compared to other factors. For example, a relatively recent study estimated that human activities are responsible for approximately 270 million bird deaths per year in Canada (Calvert et al., 2013). Combined, cat predation, and collisions with windows, vehicles, and transmission lines account for more than 95% of all avian mortality in the country. To contrast, in Canada, cats are responsible for approximately 200 million bird deaths per year, sport hunters are responsible for five million bird deaths, and wind turbines account for 16,700 (or approximately 0.006% of avian mortality). The researchers note that wind turbines are scattered across the country; therefore, bird kill totals are modest, but they may have important localized effects. The researchers also note that the cumulative effects of all human activities have significant impacts on bird populations.

Sovacool (2013) has criticized other avian mortality researchers' methodologies because they only focus on bird deaths, but not on reductions of birds' births. For example, mining activities and pollution from fossil fuels damage nesting and feeding grounds leading to declines in births. Sovacool compared avian mortality rates by energy source; finding that wind and nuclear energy are responsible for 0.3 to 0.4 fatalities per gigawatt hour (GWh) of electricity, while fossil fuel plants are responsible for 5.2 fatalities per GWh. Extrapolated nationally for the U.S., Sovacool found that wind energy was responsible for 20,000 bird deaths in 2009, nuclear energy was responsible for 330,000, and fossil fuel plants were responsible for 14 million.

Bat enthusiasts and conservation organizations have expressed concern regarding the development of wind turbines and their influence on bat mortality. Hayes (2013) found that wind farms in the U.S. are responsible for over 600,000 bat fatalities per year. Baerwald, D'Amours, Klug, and Barclay (2008) suggest that the most significant cause of bat mortality is 'barotrauma', which is caused by changes in air pressure due to spinning turbine blades. The researchers found that 90% of bat fatalities involved internal haemorrhaging consistent with barotrauma, and that direct collisions with turbine blades accounted for about half of fatalities; because bats use echolocation, air pressure change at turbine blades is an undetectable hazard for bats.

Arnett, Schirmander, Huso, & Hayes (2009) have conducted research on how to reduce bat mortality at wind turbine sites. Based on the principle that bats travel more often during periods of low wind speeds, the researchers completed a study where wind turbines were curtailed during low wind periods. The researchers found that by curtailing operations of wind turbines below certain speeds (5 metres per second (m/s) and 6.5m/s), bat mortalities could be reduced in the range of 53-87% with low marginal annual power loss from the turbines.

2.7: Political Barriers to Renewable Energy Development

Wizelius (2007) states that "politicians set the framework for wind power development and thus influence the pace of development" (p.127). Politicians directly control many aspects of renewable energy by establishing laws and regulations governing development – for example, local building permits may have to be obtained from municipalities where projects occur, or larger projects may be subject to regional or state-level environmental assessment processes. Politicians indirectly control renewable energy development by establishing the 'economic rules of the game' – for instance, implementing taxes, subsidies, and other means of control which affect energy prices. Virtually all countries and sub-jurisdictions have energy policies which have been approved by their decision-making bodies; these policies may directly support renewable energy, or inhibit their development. Because political decisions have such a significant impact on renewable energy development, and each separate jurisdiction varies widely in policies supporting renewables, only a general overview of common political barriers to renewable energy development is provided below.

2.7.1: Agreement, Knowledge, Economic, and Social Barriers at the Political Level

Most of the barriers already identified in the current literature review can also be considered political barriers. For example, section 2.2.3 describes different political ideologies which affect decision-making – if governments favour economic growth over environmental protection this may have implications for renewable energy development. Section 2.2.5 described disagreement and biased information processing and section 2.3.1 described scientific uncertainty in decision-making; both of these barriers are knowledge related, but can affect the decisions that policymakers ultimately make. Section 2.5.3 described the impact of economic subsidies – governments and politicians are responsible for designing and implementing these policies. Finally, section 2.6.1 described community opposition that can develop due to poor planning processes on behalf of policymakers. While these were originally described as agreement, knowledge, economic, and social barriers, each barrier identified has clear implications at the political level which may affect renewable energy development.

2.7.2: Lack of Political Will and Support for Renewable Energy Policy

Many researchers simply describe lack of government interest as a key barrier to the development of renewable energy sources (Martinot & McDoom, 2000). For example, Wizelius (2007) argues that a defining characteristic that contrasts countries that have been successful in developing significant amounts of renewable energy and those who have not, is the political will and support of their respective governments in implementing renewable energy policy – or more generally, the wind power policy in each jurisdiction. For example, European countries such as Denmark (21.3% of electricity from wind), Germany (7.0%), and Spain (11.8%), have seen rapid development of their wind resources. In other countries such as the UK (1.8% of electricity from wind), and Sweden (1.3%), development has been considerably slower (European Wind Energy Association [EWEA], 2008). In the successful countries, Wizelius (2007) suggests that governments have sent clear political and policy signals encouraging the rapid development of wind energy.

Elliott (2013) has argued that countries with national energy policies, which include binding renewable energy development targets, have generally been more successful in transitioning to renewables; the author contrasts Portugal (national energy policy, 45% renewables), with the USA (no binding national energy policy, 12% renewables). Elliott (2013) states: '[A decentralized] political structure makes it extremely difficult to develop a coordinated national energy policy, which can only be done my reaching consensus among many different power centres' (p.2). In the USA, 50 states regulate electric utilities, while the federal government regulates the wholesale transportation of electricity. While 27 states have binding renewable energy targets, 9 have voluntary targets; Elliott (2013) illustrates that the most ambitious target is in California (33% renewable energy by 2020), and that this is far below Western European countries such as Portugal – which have national energy policies.

In Canada, provinces who have developed substantial amounts of wind power, have seen support from their respective governments. For instance, Ontario leads the country with 4,361MW of installed capacity in 2015 (CWEA, 2016). Rowlands (2006) suggests that the provincial governments commitment to a renewable portfolio standard, as well as financial incentives for renewables in the form of feed-in-tariffs, have driven energy policy in the province.

Wiener & Koontz (2010) outline three broad categories of policy instruments politicians can implement in order to promote the development of renewable energy resources: financial instruments, mandates, and the promotion of education and awareness. First, financial instruments are designed to promote private investment in renewables, which helps overcome economic barriers, which are often cited as key barriers to renewable energy technologies (Menz & Vachon, 2006). Examples include feed-in-tariffs, net-metering, tax credits, exemptions, grants, low-interest loans, subsidies, and carbon-pricing mechanisms. Secondly, mandates support renewable energy development by establishing legal requirements for renewable energy sources; Renewable Energy Portfolios set a required percentage of renewable energy from utilities' generation by a particular date in order to promote renewables in a given jurisdiction. Finally, the promotion of education and awareness can help support the development of renewables; examples include equipment loan programs from government which allow citizens to familiarize themselves with renewable technologies, and broader programs aimed at educating and training skilled professionals in the renewable energy sector.

2.7.3: Competing Ideologies: The Environment vs. the Economy

In their analysis of barriers to wind energy development in the Canadian province of Saskatchewan, researchers found that a key impediment to renewable energy was competing philosophies regarding the development of the economy and the environment (Richards, Noble, & Belcher, 2012). Representatives from provincial non-governmental organizations (NGOs) rejected the idea of balancing the concepts of 'environment' and 'economy' – and stated that economic decisions must be made solely on the basis of protecting the environment. While decision-makers in government believed that energy decisions should be made on the basis of providing a balance between what's right for the environment, and how much we are willing to pay as consumers for products and services. Competing philosophies regarding the development of the environment and economy may hinder consensus building in the decision-making process required to advance renewable energy.

In March 2016, the Premiers of the 13 Canadian provinces and territories signed the *'5.1 Declaration on clean growth and climate change'* (Canada Intergovernmental Conference

Secretariat, 2016), committing all provinces to 'transition to a low carbon economy by adopting a broad range of domestic measures, including carbon pricing mechanisms' (para. 4). The declaration demonstrates widespread consensus on the need for carbon pricing in the country; despite this, Saskatchewan Premier Brad Wall has since argued that a federal carbon price would damage the Saskatchewan economy (CBC News, 2016).

The debate identified by Richards, Noble, and Belcher (2012) as a barrier to renewable energy development is consistent with the larger debate in the academic literature regarding society's economic and environmental relationship. For example, Carter (2001) organizes different political ideologies and their approach to the environment as either 'technocentric' or 'ecocentric'. Technocentric ideologies such as neoliberalism and conservatism are anthropocentric worldviews. They possess an unrestrained commitment to economic growth, believe science and technology will address all ecological problems, and believe that there are no limits to growth. Ecocentric ideologies such as deep ecology, ecofeminism, and ecosocialism affirm a respect for nature and a belief that all life forms should be given the opportunity to pursue their own destinies; that there are both ecological and social limits to growth; and seek to minimize resource use and operate within the carrying capacity of ecosystems. The NGO representative in the study conducted by Richards, Noble, & Belcher (2012) possessed an ecocentric worldview – while the government representative tended more towards a technocentric ideology.

2.7.4: Dominance of ‘Growth’ Ideology

The ideology of economic growth has a long history, first documented with Adam Smith’s ‘*Wealth of Nations’* in the mid-18th century; however, only since the mid-19th century has economic development based on unlimited growth become the dominant ideology and central public policy goal of most countries (Xue, 2010). A free market ideology has previously been established as a barrier to renewable energy policy and broader climate change mitigation strategies (Elliott, 2013; Heath & Gifford, 2006), as society and decision-makers are typically hesitant to question the dominant economic paradigm. However, researchers have begun to question the prevailing assumption of unlimited economic growth as a means to achieve greater prosperity – alternative economic models, not based on unlimited growth, may be more compatible with long-term sustainability and renewable energy development (Meadows et al, 1972; Daly, 1997; Victor, 2008; Jackson, 2009).

For example, Meadows et al. (1972), in their widely cited *‘Limits to Growth’*, predicted that if exponential growth trends in world population, industrialization, pollution, food production, and resource depletion continued unchanged, the limits to growth on the planet would be reached within the next 100 years.

Daly (1997) has proposed an alternative economic model, referred to as a ‘steady-state economy’(SSE). According to Czech and Daly (2004), a SSE is stable, it does not experience growth or recession. A SSE maintains constant stocks of labour, capital, and throughput (the energy and materials used to produce goods and materials). In a SSE, pollutants are generated at a rate that does not exceed the assimilative capacity of the environment. Unlike growing or shrinking economies, SSEs are generally compatible with long-term sustainability.

Some researchers have argued for slower economic growth, or for governments of developed countries to intentionally 'manage without growth' (Victor, 2008). Victor & Rosenbluth (2007) present three primary arguments against economic growth as a central policy objective: (1) continued economic growth globally is unfeasible due to environmental and resource constraints, and that the remaining room for growth should be left for less-developed countries where the benefits of growth are more significant; (2) In developed countries, continued growth is uneconomic, it detracts more from well-being than it adds; and (3) economic growth in developed countries is not necessary or sufficient for meeting policy objectives such as full employment, zero poverty, or environmental protection.

Jackson (2009) has questioned the dominant paradigm that economic growth leads to increased prosperity; he argues that materialistic consumerism is now a social logic with detrimental impacts for the environment and social organization. Jackson counters the argument of 'decoupling', or the belief of mainstream economists that reducing the rate of resource use per unit of economic activity will allow economic growth to continuously expand, within the earth's finite limits; using the example of climate change, he demonstrates that as gross national product (GNP) continues to grow, GHG emissions inevitably increase. Jackson proposes an alternative economic model, one which is not based on consumption and growth, but instead puts human-welfare as its central priority – allowing society to flourish within the limits of a finite planet. Jackson (2009) concludes 'prosperity goes beyond material pleasures – it transcends material concerns' (p.16) – and instead, a sustainable economy should be built which pursues relationships, family, community, and a meaningful life, as its central priority.

2.8: Knowledge Gap

A central knowledge gap of the current project is that limited academic work has been conducted on wind energy development and other renewable energy sources in Newfoundland and Labrador. Researchers such as Blackler and Iqbal (2006) have studied the technical feasibility of a single wind farm installation in Newfoundland; Jewer, Iqbal & Khan (2005) have completed a wind resource map for the mainland portion of the province; Khan & Iqbal (2004) have completed a wind resource map for the island of Newfoundland; and Fisher, Iqbal & Fisher (2009) have studied the technical feasibility of small-scale hydroelectricity and wind in the province. Non-academic work commissioned and completed by government sources include the *Preliminary Assessment of Alternative Energy Potential in Coastal Labrador* (NL Hydro, 2009a), *Wind Integration Study – Isolated Island* (Hatch, 2012), *Technical Study of Voltage Regulation and System Stability*

(Navigant, 2011), and energy road mapping exercises (Department of Natural Resources, 2016). Most of these studies focus on the science and technology of wind energy development, and do not consider social-science components; the current thesis intends to make a contribution in filling this gap.

As the current literature review demonstrates, barriers to renewable (especially wind) energy development are complex and varied. Despite this, the existing research in NL has largely concentrated on the technical feasibility/availability of wind energy in the province, and a limited number of government sources have investigated the economic feasibility. There are very few, if any, studies investigating broader agreement, knowledge, societal, or political related barriers to renewable energy development in Newfoundland and Labrador. Investigating barriers to renewable energy development outside of the technical realm will help policymakers have a more comprehensive view of energy sustainability in the province.

The current literature review demonstrates that barriers to renewable energy development do not occur in isolation. For example, while existing fossil fuel subsidies may act as a barrier to renewable energy development – these subsidies also have clear political implications. Many of the barriers identified in the agreement and knowledge categories, such as expert disagreement and biased information processing, are also evident at the political level. Due to the complex interaction of these barriers, it is necessary to take an interdisciplinary and exploratory approach which will enable further understanding of the province’s energy sector and the potential to overcome these barriers and transition to a cleaner energy policy.

Chapter Three: Research Methodology

3.1: Research Questions and Overview of Methodology

The overall purpose of this project is to identify barriers to energy transition in Newfoundland and Labrador, with a focus on the development of wind energy. The current research sets out to explore barriers to wind energy development in Newfoundland and Labrador including agreement, knowledge, technological, economic, social, and political issues. Based on the identified barriers, a policy framework will then be developed which may help in addressing some of the complex issues affecting renewable energy development in the province.

As previously outlined in Chapter One, the research objectives for the thesis are:

1) To apply a case-study approach – concentrating on Newfoundland and Labrador - which enables an understanding of the complex barriers to renewable energy development (with a focus on wind energy) in a provincial context.
2) To implement Trudgill's (1990) 'AKTESP' (agreement, knowledge, technological, economic, social, and political barriers) framework for analysis in order to organize and analyze empirical evidence and to guide the discussion of barriers to wind energy development and possible solutions.

3) To develop a region-specific policy framework consisting of recommendations which will help in addressing barriers to renewable wind energy development in Newfoundland and Labrador.
4) To conduct an exploratory study which identifies critical areas of future research in Newfoundland and Labrador energy policy.

As previously listed in Chapter One, the central research questions for the current project are :

1) Adhering to Trudgill's 'AKTESP' framework for analysis, what are the most significant barriers (agreement, knowledge, technological, economic, social, and/or political) to wind energy development, as well as disadvantages in a provincial context, and how do they interact to inhibit development in Newfoundland and Labrador?

Secondary research questions include:

2) What are the primary benefits of wind energy development in a provincial context?
3) Based on the barriers identified in the study, which policy measures would encourage the development of a viable wind energy industry in the province?

With the study's objectives and research questions in mind, the following chapter aims to give an overview of the current research methodology. The chapter aims to (a) discuss the theoretical framework of the thesis, (b) discuss the applied analytical framework, (c) identify and provide rationale for the research approach and data collection procedures, (d) discuss participant recruitment and sampling strategies, and (e) identify and provide rationale for data analysis techniques.

3.2: Theoretical Framework: Harris' 'Great Energy Transition' Concept

The thesis is based on the theoretical foundation of "the great energy transition" concept as developed by Harris (2006). Harris explains how historically, as firewood and other biomass became insufficient to support growing economies, many societies moved towards hydroelectricity, then coal, then oil and natural gas, and in the latter half of the 19th century, to nuclear power, as their primary energy sources. According to Harris (2006), "each stage of economic development has been accompanied by a characteristic energy transition from one major fuel source to another" (p.280). Fossil fuels are the primary energy source in today's industrial economies; according to the assumptions of Harris' theoretical framework, the 21st century will see a further great transition in energy sources.

The great transition theory is grounded in the laws of thermodynamics (Harris, 2006). The first law of thermodynamics states that energy can neither be created nor destroyed;

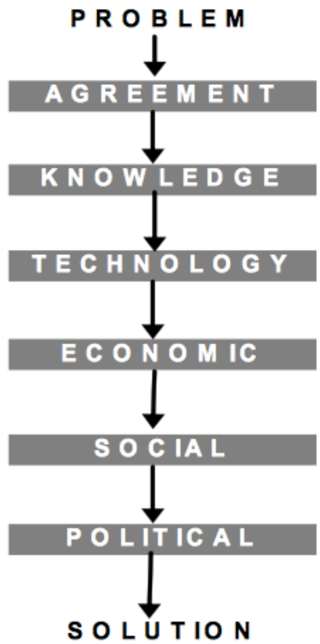
all physical processes merely move or transform energy. All physical processes are also subject to the second law of thermodynamics. The second law of thermodynamics is related to the concept of entropy; entropy is defined as a measure of unavailable energy, or energy in a form that is not available to do work. The second law states that entropy increases in all physical processes; that is, all physical processes, including economic processes, transform low-entropy inputs into high-entropy waste outputs.

Therefore, all economic processes are limited by the availability of low-entropy resources. Low-entropy resources come in two forms; stocks of non-renewable resources such as fossil fuels, and the flow of renewable energy available from the sun. Harris (2006) states "our current economic activities depend heavily on the use of limited stocks. Ultimately, we must adapt our economic system to use the flow of solar energy, or solar flux" (p.281). When referring to the 'solar flux', Harris (2006) means any form of renewable energy ultimately derived from the sun's processes; according to NRCAN (2015) all forms of renewable energy – such as solar, wind, biomass, and hydropower, oceans' resources such as wave and tidal, as well as biofuels - are derived directly or indirectly from the sun, or from heat generated deep within the earth.

3.3: Analytical Framework: Trudgill's (1990) 'AKTESP' Framework for Analysis

The thesis implements Trudgill's (1990) 'AKTESP' framework for analysis in order to organize and analyze empirical evidence and to guide the discussion of barriers to wind energy development and possible solutions. Trudgill identified six major groups of barriers to achieving a better environment – agreement, knowledge, technological, economic, social perception, and political will – which are collectively referred to as the AKTESP framework **(Figure 3.1).** Each of the major groups of barriers may not exist in an orderly manner and they may sometimes overlap each other. In barrier identification, each stage of the AKTESP framework is constantly being questioned whether it impedes progress towards a solution. For example, if the first barrier to the problem is addressed – i.e. all parties are in agreement to act on the issue, the next step is to identify whether there is adequate knowledge on the cause and effects of the problem. Furthermore, even if there is agreement on the problem and the cause and effects are clearly known, a lack of appropriate technology to solve the problem may be a major barrier. Likewise, even if the technology is available to solve the problem, it may be uneconomical to pursue a solution, it may not be socially acceptable, or there may be lack of political will to pursue the solution.

Figure 3.1: Trudgill's (1990) AKTESP Framework for Analysis



Trudgill further described the groups of barriers in the following manner:

1) AGREEMENT: Situation recognition but problem denial; Problem recognition but problem rejection; Problem acceptance but causal uncertainty; Problem dismissal.
2) KNOWLEDGE: Knowledge inadequacy; Knowledge adequacy but knowledge rejection; Knowledge adequacy but knowledge inappropriateness; Knowledge adequacy but knowledge uncommunicated.

3) TECHNOLOGY: Technology unavailability; Technology availability but technology complacency; Technology availability but technologically inappropriate.
4) ECONOMIC: Economic insufficiency; Economic denial; Economic inappropriateness; Economic exploitation.
5) SOCIAL: Social value systems; Social resistance; Social leadership; Social allocation; Social morality.
6) POLITICAL: Political cynicism; political ideology.

As it is obvious from Trudgill's description, all the barriers have multiple aspects that may be used in analysis.

3.4: Research Design: A Qualitative, Case-Study Approach

Applying Trudgill's (1990) AKTESP framework as its analytical focus, this primarily qualitative and exploratory research uses a case study research design. Secondary data is including government documents, statistics, and other sources of grey literature are used to support the study throughout – particularly in the discussion chapter. Due to the significance of Newfoundland and Labrador's over-reliance on fossil fuels, and the abundant availability of renewable energy resources in the province, the provincial energy sector is a unique case study that warrants in-depth analysis. According to Yin (1994) "how" and "why" questions favour the use of case studies, and "what" questions are justifiable rationale for conducting exploratory research – this is consistent with the research questions of the current project, and supports the decision to use a single, case-study approach.

Furthermore, this study is consistent with the existing literature which investigates barriers to renewable energy development. Research undertaken on barriers to renewable energy penetration is often qualitative case-studies (Richards, Noble, Belcher, 2012; Jagadeesh, 2000; Reddy & Painuly, 2004). For these reasons, this research design enables, with the help of the AKTESP framework an in-depth understanding of the barriers to wind energy development in the province. The timeframe for analysis is generally from 2007 (when the province's last Energy Plan was published) to January 15, 2016 (the end of the data collection period).

3.4.1: Data Collection Procedures: Semi-Structured Expert Interviews

The primary method of data collection for the current project was semi-structured expert interviews **(Appendix A)**. Semi-structured interviews involve a series of open-ended questions based on topics the researcher wants to cover. The AKTESP Framework served as the analytical focus for the project and the interviews were organized around the themes of agreement, knowledge, technological, economic, social, and political related issues. For each category, an open-ended question was posed, for instance, within the knowledge category the researcher first asked "How would you describe the level of knowledge and understanding about wind energy in a provincial context?" Participants were allowed to respond freely; based on their responses, the interviewer prepared a number of probe questions to obtain additional information (i.e.: "how would you describe the level of research occurring in the province to support wind energy development?)".

While most questions posed were open-ended in nature, the researcher did include a small number of structured questions. At the beginning of the interview, participants were asked to "Please describe the current state of wind energy development in the province" as either favourable, unfavourable, or they were not sure. Additionally, at the end of each AKTESP category question, participants were asked "Do you believe that Category X is a significant issue affecting the rate of wind energy development in Newfoundland and Labrador?" –and responses were limited to yes, no, or not sure. Structured questions included as definitive yes/no answers to barrier identification were helpful during the data analysis phase of the project.

3.4.2: The Interview

All interviews for the project were conducted between September 1, 2015 and January 15, 2016. The majority of interviews took place at a private location of the participant's convenience (i.e. participant's office, rented classroom space, etc.). If participants were unavailable for an in-person interview, interviews were conducted via telephone (five of 17 interviews were conducted via telephone). Each interview lasted approximately 45-75 minutes in length; a time limit was set at 90 minutes for each interview. With the permission of each participant, as set out in the informed consent process, each interview was recorded digitally. The researcher used two recording devices for each interview, in the case that one failed. Interviews were digitally recorded in order to be transcribed.

3.4.3: Ethical Considerations

The researcher has followed the prescribed procedure for ethical clearance of the project. The Grenfell Campus Research Ethics Board (GCREB) gave ethical approval to this project – stating that participants in the current study faced no financial, physical, or psychological risks. The GCREB did, however, identify one potential social risk of the current project – that due to the level of expertise sought for this research, it was possible that some respondents may be identifiable from their comments or due to their expertise and the specific knowledge associated with their position. There were potential negative consequences of being identified if participants said something negative about current practices. Research participants were made aware of this potential social risk through the informed consent process.

In order to address this specific social risk, all reasonable efforts were made to ensure that research participants remained anonymous and confidential. All data collected for the project was stored on a password protected flash drive, and data was organized according to each participant's pseudonym chosen by the researcher. All publications and reports resulting from this research do not use participants' names – unless explicit consent was given by the individual. Additionally, all research participants were given the option to remove their data from the current project up to an official withdrawal date of January 15, 2016 set by the researcher.

3.5: Research Participants - Target Population

As demonstrated in Chapter 2, barriers to renewable energy development are complex and varied; they include issues such as agreement, knowledge, technological, economic, societal, and political issues; therefore, it was necessary to recruit participants for this study that represented a wide range of expertise and a diversity of opinions.

The target population for the current project was experts in the field of renewable energy development who possessed extensive knowledge in a minimum of one of the categories in Trudgill's (1990) 'AKTESP Framework for Analysis' (agreement, knowledge, technological, economic, social, and/or political will). In order to provide a balanced perspective, participants were recruited evenly from the following four categories: academics, government, non-profit organizations/community groups, and the private sector.

The search for experts was limited to those who possessed specific knowledge on the energy sector of Newfoundland and Labrador – that is, participants did not have to reside in the province, but they had to demonstrate expertise of the province's energy sector.

Participants were only included in the study if they possessed a minimum of two years' experience working on relevant issues. The only participants who were excluded from the project were those who were unable to communicate effectively in English, as this was the language of the investigator and the language in which interviews were conducted. The researcher invited 32 experts in total to participate in the study (a limited number of participants refused to participate – the remainder simply failed to respond to the research invitation), ultimately interviews were conducted with 17 individuals (n=17); this consisted of four academics, four government representatives, four representatives of community groups, and five private sector actors. **Table 3.1** provides details of research participants by target groups.

3.5.1: Overview of Target Groups in NL

According to NRCAN (2016), in Canada, the generation, transmission, and distribution of electricity fall primarily under provincial jurisdiction; provincial governments exercise this jurisdiction through provincial Crown utilities and regulatory agencies. In NL, the Department of Natural Resources has primary responsibility for the stewardship and development of the province's natural resources through the Mines and Energy Branches (DNR, 2015). Other government offices play a role in the provincial energy sector; for example, the Department of Environment and Climate Change, through the Office of Climate Change and Energy Efficiency, is responsible for strategy and policy development on climate change, energy efficiency and emissions trading (OCCEE, 2016).

A crown corporation, the Research and Development Corporation [RDC], focuses on energy related-issues as a key area of research (RDC, 2014).

In 2007, the Government of NL created a new provincial energy corporation – Nalcor Energy – to manage the development of the provinces energy resources. Nalcor Energy's primary business is the generation and transmission of electrical power, although the company also focuses on oil and gas development, research and development, and wind power (Government of NL, 2008). Newfoundland and Labrador Hydro is the provinces only public electric utility, and is a division of Nalcor energy, the company is the primary generator of electricity in the province (NL Hydro, n.d.)

Newfoundland Power is an important private-sector electricity utility in NL; responsible for the transmission and distribution of power on the island portion of the province. The company purchases 93% of it's energy from Newfoundland Hydro, and generates the remainder through 23 of its own small hydroelectric generating facilities (DNR, 2016). There are currently two utility-scale wind operators in the province, Enel Atlantic Canada Limited Partnership, as well as Elemental Energy (DNR, 2016). There are also a number of small-scale renewable energy companies operating throughout the province that focus on off-grid and remote installations.

NL has two primary post-secondary education institutions: Memorial University and its affiliates, as well as the College of the North Atlantic (Government of Canada, 2016). In particular, Memorial University's Faculty of Engineering and Applied Science, as well as the Leslie Harris Centre of Regional Policy and Development, have focused on energy-related research. The College of the North Atlantics Wave Energy Research Centre, as well as various engineering programs, have also conducted energy research.

NL has numerous environmental non-governmental organizations that focus on environmental conservation and education (Newfoundland and Labrador Environmental Network, n.d.), with many concentrating specifically on climate change, community sustainability, and air quality. The NLEN currently has 45 active ENGO members (Wellness Coalition Avalon East, 2016), many of which contribute to energy debates in the province.

Academics (n=4)	Community Groups (n=4)	Government (n=4)	Private Sector (n=5)
An energy economist	A director of energy policy at an Atlantic Canadian Environmental Non-Governmental Organization (ENGO)	An executive of a provincial Crown corporation who has completed research on the province's energy sector	A power utility representative with vast experience in wind energy integration studies
An electrical engineer/energy policy researcher	A chairperson from a Newfoundland ENGO which has promoted wind energy as source of power in the province	A director of a provincial government office responsible for energy related decisions	An executive of a provincial small-scale renewable energy company
An electrical engineer studying wind and renewable energy systems	An executive of a Labrador ENGO who sees advanced wind energy as an alternative source of energy in the province	A representative of the provincial Crown energy corporation	An executive representing a utility-scale wind energy company with a project in Newfoundland
A retired economics professor with interests in the provincial energy sector	An executive director of a Canadian energy policy ENGO – with interests in Newfoundland & Labrador	A director of a provincial government office in a natural resource related portfolio	An executive of a National wind energy organization with interests in Newfoundland & Labrador
			An executive of an industry association with interests in Newfoundland & Labrador's energy sector

Table 3.1: Details of Research Participants by Target Group

3.5.2: Sampling Procedures & Techniques

According to Patton (1990), most quantitative inquiry relies on probability sampling, where samples are selected that are truly random and representative to allow for generalization to a larger population. In contrast, non-probability sampling allows for selecting information-rich cases for in-depth study. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research. Kumar (2014) provides an overview of non-probability sampling "Non-probability sampling designs do not follow the theory of probability in the choice of elements from the sampling population. Non-probability sampling designs are used when the number of elements in a population is either unknown or cannot be individually identified" (p.206).

As per the research objectives of this study, the purpose of the research was not generalization, but instead it was an exploratory study which sought to investigate an area of which little was known. Additionally, it was unknown and highly difficult to determine how many renewable energy experts exist that possess specific knowledge of Newfoundland and Labrador's energy sector. Therefore, probability sampling procedures were inappropriate for the current study and the researcher had to select participants based on other criteria. As explained by Kumar (2014), "In such situations (where the number of elements in a population is unknown) the selection of elements is dependent upon other considerations" (p.206). Thus, the researcher had to employ purposeful sampling methods.

The primary sampling technique employed in the study was expert sampling. According to Kumar (2014), expert sampling is a form of purposive sampling, where the primary consideration is the researcher's judgement as to who can provide the best information to achieve the objectives of the study. Where expert sampling differs from purposive sampling is that participants selected for the study must demonstrate extensive knowledge or experience in the field of interest. Kumar (2014) states that "this type of sampling is extremely useful when you want to construct a historical reality, (or) describe a phenomenon of which only a little is known" (p.207). As per section 2.8. (Knowledge Gaps) of the literature review, minimal work has been conducted in this field of interest – expert sampling is thus appropriate for the objectives of the study.

A secondary sampling technique employed in this study was snowball sampling. Kumar (2014) defines snowball sampling as the process of selecting a sample using networks. In this technique, a preliminary group of individuals is selected and information is collected from them. These individuals are then asked to identify other people who may be able to contribute to the study's objectives, and the process is continued until adequate information is collected. A modified version of snowball sampling was employed in this study; after additional individuals were identified by participants, the researcher then investigated their backgrounds and experience and if the individuals met the 'expert' criteria identified in section 3.5, they were then invited to participate in the study. According to Kumar (2014) “this sampling technique is useful if you know little about the group or organization you wish to study” (p.208). As explained in section 3.5.3**,** a central challenge of this study was identifying individuals within certain sub-groups that possessed knowledge pertinent to the topic; snowball sampling helped address this challenge by identifying potential participants who otherwise would not have been discovered.

3.5.3: Recruitment of Participants

The data collection period for this project began on September 1st, 2015. Prior to this date, an original group of ‘expert’ participants were identified by the researcher based on specified criteria (Section 3.5). The participants identified were then sent a copy of the Recruitment Letter **(Appendix B)** via email. The recruitment letter informed participants of the objectives of the study, what would be expected of them, details regarding how results would be reported, and an invitation to participate in an interview either in-person or via telephone, depending on the participant’s availability on a specified date.

As outlined in section 3.5.1, snowball sampling was an additional sampling technique employed in this study. Therefore, as additional participants were identified throughout the data collection period (September 1st, 2015 – January 15th, 2016), they were invited to participate with the recruitment letter described previously.

Once an expert agreed to participate in the study and a time and date were set for the interview, participants were then sent a copy of the interview questionnaire in order to familiarize themselves with the interview content. Participants were also sent a copy of the informed consent form at this time. This form provided greater detail on the objectives of the study; what was expected of participants; a full description of the projects risks and benefits; measures taken to ensure confidentiality, anonymity, and the participants' right to withdraw; as well as a section to obtain explicit consent to participate.

3.5.4: Challenges Encountered in Securing Research Participants

1) The 'Gatekeeper Effect' in Data Collection

A challenge encountered during the data collection phase of this project was 'the gatekeeper effect', a term coined by Calhoun (2002). Calhoun describes a "gatekeeper" in social science research as "an individual who occupies a position that allows him or her to control access to goods, information, and services. Such power often extends well beyond the formal authority of the gatekeeper's official position". Calhoun notes that gatekeepers are common in bureaucratic settings and other hierarchical organizations.

A "gatekeeper" was encountered who controlled access to information (in the form of research participants) within one of the sub-groups identified in **Table 3.1**. The gatekeeper established themselves as the sole point of contact within a specific entity, and informed the researcher that they believed multiple interviews within their organization were unlikely and unnecessary. The researcher attempted to address this by sending multiple emails explaining the importance of obtaining multiple perspectives and maintaining the credibility of the data collected, and identifying additional 'experts' whom would be beneficial for the study. The gatekeeper ultimately set up a single interview within their entity, but did not allow for additional interviews with identified experts.

In order to address this challenge, the researcher employed a snowball sampling method in order to identify additional experts who had not yet been invited to participate in the research. Ultimately, the researcher was able to conduct a balanced amount of interviews within each sub-group of actors.

2) General Lack of Capacity in the Province

A challenge encountered during the data collection phase of the project was a general lack of capacity in the wind energy industry throughout Newfoundland and Labrador. For example, there are only two utility-scale wind farms in the province and neither company is headquartered in the province, therefore it was difficult to secure private sector actors with direct experience in the Newfoundland and Labrador energy sector. This challenge was present within most of the sub-groups in **Table 3.1**; due to the fact that the wind energy industry is limited in the province, there is a general lack of individuals with adequate experience in government, community groups, and academia who could be invited to act as respondents.

The snowball sampling technique was beneficial in addressing this challenge as individuals recruited for the project were able to refer the researcher to other experts within their networks (Kumar, 2014). While it took a significant amount of time and dedication, the researcher was ultimately able to secure balanced representation of participants from each sub-group throughout the data collection period.

3.6: Data Analysis Technique: Content Analysis (Assisted by NVIVO Software)

Content analysis: The primary form of data analysis applied in the study was content analysis. Expert interviews were digitally recorded, manually transcribed by the researcher, and content analysis was applied with the assistance of the NVIVO software. The researcher coded transcripts according to the categories of the AKTESP Framework for Analysis – allowing the researcher to essentially identify themes that represented the most significant barriers to wind energy development in Newfoundland and Labrador. Content analysis was also employed to gather insights from respondents regarding possible policy solutions to encourage the development of renewable sources of energy in the province.

Hsieh and Shannon (2005) define qualitative content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (p.1278). Content analysis involves a process designed to reduce raw textual data into categories or themes based on valid inference or interpretation (Zhang & Wildemuth, 2009); this method is used to explore the meanings underlying physical messages.

The process of content analysis typically involves *inductive reasoning*, whereby themes and categories of information emerge from the data through the researcher's examination and constant comparison (Zhang & Wildemuth, 2009); however, Patton (2002) notes that content analysis can also use *deductive reasoning*. For example, the current project applied a form of content analysis known as 'directed content analysis' in which initial coding starts with theory or relevant research findings, in this case transcripts were coded according to the AKTESP framework for analysis. During the analysis, the researchers then immerse themselves in the data and allow themes to emerge from the data according to predetermined categories; the purpose of this approach is usually to validate or extend a conceptual framework or theory (Zhang & Wildemuth, 2009).

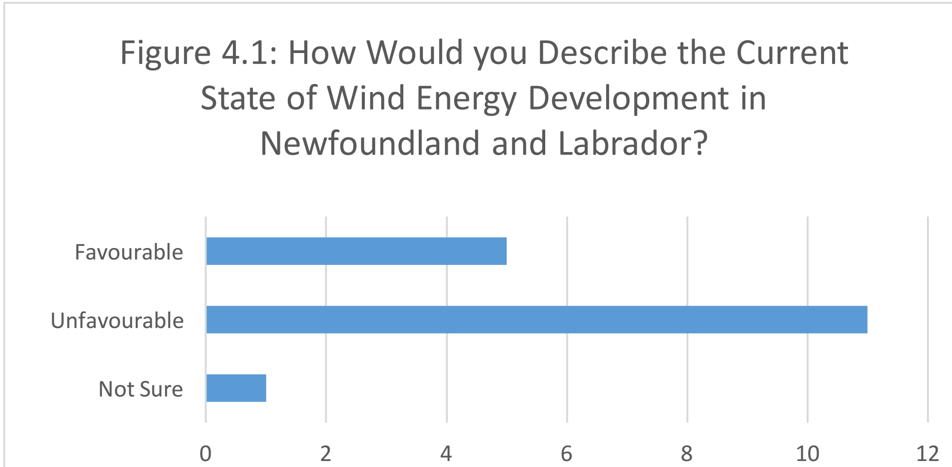
Zhang and Wildemuth (2009) note that qualitative content analysis is often supported by computer programs – in this case the researcher used the NVIVO software – to assist in organizing, managing, and coding qualitative data in a more effective manner.

Chapter Four: Findings

4.1: Introduction to Findings

In the study, 17 expert participants were interviewed regarding barriers to renewable energy development – with a focus on wind power - in Newfoundland and Labrador; participants were drawn evenly from academia, ENGOs, government, and the private-sector **(Table 3.1)**. While the interviews were predominantly open-ended in nature, a number of structured questions were asked in order to identify: (a) expert opinion on the current state of wind energy development in the province, and (b) expert perception on the most pressing barriers to wind energy development in NL; the responses to these questions will be presented in this chapter.

As an introduction to the interview, all 17 expert participants were asked to classify the current state of wind energy development in NL as either 'favourable', 'unfavourable', or 'not sure'. Responses to this question are presented in **Figure 4.1.** The majority of participants (65%) believed that the current state of wind energy development in the province was unfavourable.



Moving beyond the introduction portion of the interviews – each category of the 'AKTESP' framework for analysis was then discussed individually **(Figure 3.1).**

The findings chapter is broken down into two central components. The first section (4.2) will discuss what experts perceived as the primary barriers to wind energy development in NL according to the 'AKTESP' framework for analysis. The second section (4.3) will present the potential economic, environmental, and societal benefits of wind energy development in the province, as determined by expert elicitation.

4.2: Barriers to Renewable Energy Development in Newfoundland and Labrador: A Case Study of Wind Energy Applying the AKTESP Framework for Analysis

This section reports what experts perceived as the most significant barriers to, and disadvantages of, wind energy development in a provincial context – as determined by qualitative data analysis, and organized according to the AKTESP framework for analysis. This section addresses the central research question:

1) Adhering to Trudgill's 'AKTESP' framework for analysis, what are the most significant barriers (agreement, knowledge, technological, economic, social, and/or political) to wind energy development, as well as disadvantages in a provincial context, and how do they interact to inhibit development in Newfoundland and Labrador?

Participants discussed each category of the AKTESP framework for analysis; at the end of each category, participants were asked if this category of issues represented a barrier to wind energy development in NL. **Figure 4.2** provides an overview of what expert participants perceived to be the most significant barriers to wind energy development in Newfoundland and Labrador – these themes will be explored in-depth in this chapter.

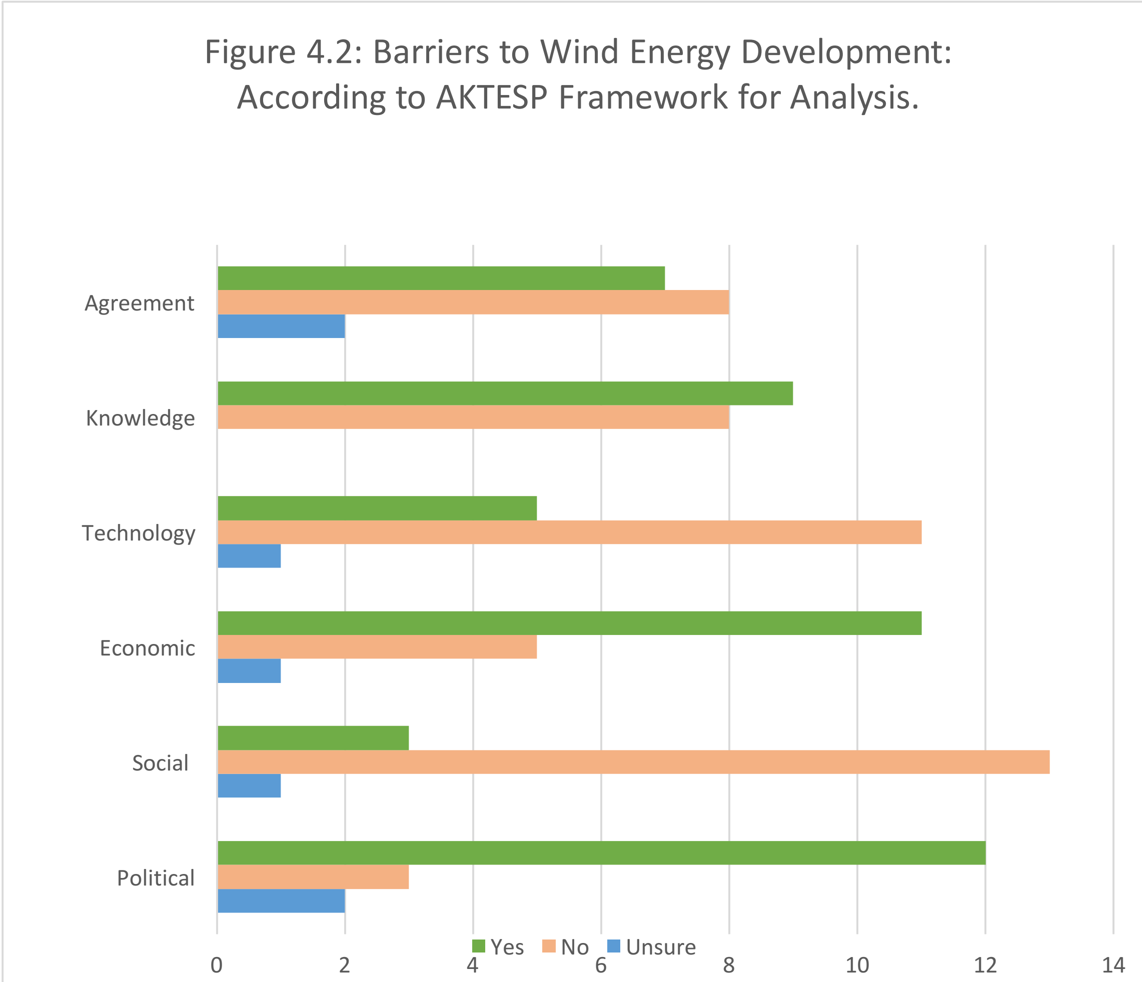


Table 4.2 provides an overview of the central themes that emerged within each category of the AKTESP framework, as determined by expert elicitation and qualitative data analysis techniques. In total, 24 themes were developed.

Agreement	Knowledge	Technological	Economic	Social	Political
Disagreement over Potential for Job Creation and Economic Benefit	Energy Literacy: Inadequate Knowledge and Understanding About Wind Energy	Wind Intermittency: Required Backup, Acceptable Penetration Levels, and Energy Storage	Cost Competitiveness of Wind Energy	NIMBY Phenomenon	Institutional Barriers
Approach to Development: Mega-Project Mentality vs. Small-Scale Projects	Siloed Knowledge: Absence of Social Science Research	Icing of Turbines in Harsh Environments	Insufficient Provincial Demand - Limited Access to Export Markets	Noise Impacts	Lack of Government Policy, Targets, and Political Will
Resource Potential vs. Technical Limitations	Lack of Expert Capacity, Trained Professionals, Educational Programs	Spilt Energy: Implications of the Existing Electrical System	Existing Monopoly in Electricity Sector	Avian Mortality	Governmental Preoccupation with Muskrat Falls, Oil & Gas Development
		Other Technical Concerns	Fossil Fuel Subsidies and Externalities	Aesthetic Impacts	Inadequate Public Consultation Regarding Energy Policy Decisions
					Governmental Preference for Continuation of Status Quo
					Legislative Barriers: Bill 61

Table 4.2: Barriers to Wind Energy Development in NL According to the 'AKTESP' Framework for Analysis

4.2.1: Agreement Barriers to Wind Energy Development in NL

The "agreement" category of issues showed the greatest level of disagreement among participants; 41% of participants believed agreement-related issues were a significant barrier to wind energy development in the province, 47% believed this was not a significant issue, and 12% were unsure **(Figure 4.2)**. This section provides an overview of the central themes which emerged in this category including (1) disagreement over potential for job creation and economic benefits, (2) approach to development: mega-project mentality vs. small-scale projects, and (3) resource potential vs. technical limitations.

Disagreement over Potential for Job Creation and Economic Benefits

Participants differed widely as to whether or not they believed wind energy could be a source of job creation and economic benefit in the province; while most participants were optimistic about the potential for job creation and economic benefits, at least one expert from each target group (academia, ENGO, government, and the private-sector) expressed non-confidence in wind energy's potential to create employment. If decision-makers do not see wind energy as a viable source of job creation and economic development, it may prevent them from creating policies which support the development of the industry.

An optimistic ENGO representative stated, "A benefit of developing a local wind industry in Newfoundland and Labrador is that it could employ a bunch of people and help generate local prosperity". Similarly, a private sector respondent stated: "The immediate benefit of [wind energy development] would be big time employment'' later adding "If we got one big local [wind turbine/component] manufacturer here in Newfoundland... we would be looking at 2500 full-time jobs".

Some participants were not optimistic about wind energy's potential for job creation. A government representative stated "There is very little economic benefit, jobs, labour, or GDP created from wind energy" later adding "Is it a good rural job creator? I doubt it". A private-sector respondent echoed this sentiment "It is a good job creator during the construction phase of the project, it is a very limited job creator once the project is in operation" later adding "for the first four years [at a provincial wind farm] we had two operators, and now we are able to continue with just one operator".

Approach to Development: Mega-Project Mentality vs. Small-Scale Projects

Participants generally have acknowledged that there is a government preference for developing mega-projects as an approach to economic development, as opposed to small-scale energy projects; and this represents a barrier to wind energy development.

Representatives of ENGOs were particularly critical of the mega-project approach to development. As one representative stated, "The mega-project mentality is a barrier to wind… we cannot bring ourselves to believe that if you just build a whole bunch of small projects, you will create way more jobs, and generate more money in the economy". Another ENGO representative stated "If your attitude is big is better, then you will prefer things like massive hydro projects. If you are more community-minded, and you want to see each little community prosper, then you think smaller projects like small wind and hydro".

Resource Potential vs. Technical Limitations

There was a knowledge gap among participants between the vast potential for wind energy development in the province and the technical limitations which affect how much wind energy the current system can absorb (these limitations are explored in section 4.2.3). As a utility representative stated, "I believe there is a perception that Newfoundland and Labrador is a windy place, and that there should be more wind energy development; in the absence of knowledge of the technical limitations of the system, I would whole-heartedly agree". Taking an overly optimistic perspective regarding wind energy potential may hinder the development of effective strategies to achieve realistic targets of wind power on a utility scale, as well as in remote communities.

Eleven out of 17 participants described the current state of wind energy development in the province as "unfavourable", while five participants described the current state of development as "favourable" **(Fig. 4.1)** – suggesting that the majority of participants were unsatisfied with the current amount of wind energy integrated into the system. Furthermore, 13 participants promoted wind energy in the province based on the quality of the province's wind resources; as a private-sector respondent stated, "the quality of the wind resources in the province is such that there is potential for a lot, a lot of wind farms in Newfoundland". Conversely, only five of 17 participants believed that technical limitations are affecting the current rate of wind energy development in the province. While many technical issues were discussed with the participants, the issues of intermittency, icing, as well as spilt energy at existing hydroelectric facilities, emerged as key technical limitations to integrating additional wind energy in the province.

4.2.2: Knowledge Barriers to Wind Energy Development in NL

A small majority of participants (53%) believed that "knowledge" related issues were affecting the rate of wind energy development in the province **(Figure 4.2)**. The themes which emerged in this category included (1) energy literacy: inadequate knowledge and understanding about wind energy, (2) siloed knowledge: absence of social science research, and (3) lack of expert capacity, trained professionals, and educational programs.

Energy Literacy: Inadequate Knowledge and Understanding about Wind Energy

At least 15 expert participants (88% of respondents) believed that there was an inadequate knowledge and understanding about wind energy in NL. As an ENGO representative stated, "there is not a huge level of knowledge... about wind energy in Newfoundland and Labrador". A government representative stated, "I do not think the general public has a clue [about wind energy]". If key actors lack knowledge about wind energy, and widespread misinformation exists about the technology, this may hinder its development and public support as an energy source in the province.

Participants believed that there is a high level of misinformation about wind energy in the province, as a utility representative stated: “Some people think wind energy is cheap, some people think that it is expensive. I have heard all sorts of stories; but I don’t think people understand what it is”; this respondent also added: “I have heard so many myths about why we can, or cannot, do wind projects. It has led me to believe that the general public is not well informed”. An ENGO representative stated, “People believe that wind energy is intermittent or unreliable… or that the wind is too strong for the wind turbine blades… these comments were coming from members of the Nalcor board, these board members are not very knowledgeable”.

Some participants acknowledged that the low levels of knowledge and understanding about wind energy may be attributed to lack of exposure to the technology. As a private-sector respondent stated, “people in Newfoundland have very little exposure to wind energy, compared with people from the southwest part of Ontario, for example”. A government representative stated, “I do not think people in the province even know that [wind energy] exists here”. An ENGO representative stated, “I think most people are too busy to delve into the issue [of energy supply] deeply”.

Siloed Knowledge and Absence of Social Science Research

There was a high level of disagreement among participants regarding the current level of research taking place in the province to support wind energy development, suggesting that existing research has occurred in isolation (siloing of knowledge) and has not been properly communicated to all community groups, private industry, and academics in the province. Furthermore, participants could not identify any social science research previously completed in the province.

Many participants argued that there was a lack of research to support wind energy in the province. An ENGO representative stated, "[the provincial government] has not done any research on wind in thirty years", while a private actor stated, "the research is completely inexistent", and an academic participant stated "At Memorial University, or anywhere else, there is very little research going on [regarding wind energy]".

Conversely, other participants contended there was a high level of research taking place. As a utility representative stated "There is sufficient research taking place from a technical perspective" later adding "there is a lot of investment in wind industry research [from their company] … a lot of research and collaboration with government on understanding wind resources in isolated communities". An academic participant stated, "There is definitely some research being done; including in the province with their road mapping exercise". Another academic respondent stated, "There is significant research being conducted; there is quite strong interest, and reasonable research funding".

While a number of utility and academic representatives stated they were aware of a substantial amount of technical research, the fact that community groups, private-sector actors, and even other academics were unaware of these efforts suggests that the existing research has occurred in "research siloes"[1] and has not been properly communicated. This has resulted in the disconnect between various parties, concerning knowledge of ongoing wind energy research. As one ENGO representative stated, "There does not seem to be a connection between the great research that's happening at Memorial University of Newfoundland (MUN), and the general culture of knowledge around renewable energy in NL".

Furthermore, while an arguably large degree of technical research has been carried out, there has been little research on a broader-scale, or from a social science perspective. As a utility representative stated, "There is not a lot of research happening in the area of utility-scale generation, because we are not a large utility scale wind jurisdiction".

[1] Mitchell (2005) defines the 'silo effect' as "the separation of responsibilities among resource-management agencies as well as their inability or unwillingness to consider their mandate relative to those of other organizations" (p. 1340).

Lack of Expert Capacity, Trained Professionals, Educational Programs

Participants generally acknowledged that there is a lack of expert capacity and trained professionals in the wind energy industry in NL, and that this may be attributed to a lack of educational and training programs in the field. As an ENGO representative stated, "There are no people in the environmental field [provincially]". This is a clear barrier to wind energy development; as without trained professionals to work in the industry, wind energy is unlikely to develop further in the province.

Participants generally believed that training at the postsecondary level is limited in the province – and educational opportunities that do exist are technical in nature, with limited exposure to social science aspects of renewable energy development. One academic explained "[at our provincial university] we give some introduction to wind engineering and renewable energy systems. Presently, we have three courses in engineering that specifically deal with it" later adding, "I don't think there are any courses [in the provincial college system] that deal with wind turbines, or renewable energy systems". A private-sector actor stated "There's (sic) no graduate programs concentrating on alternative energy in the province… many of the graduate students in [environmental] fields, do not study wind energy – because there is a lack of thesis opportunities here".

Some participants also criticized exposure and basic education of renewable energy at the grade school level. A private-sector respondent stated "Sometimes, children that have graduated high school – [they might have seen] examples of wind turbines in math (or science) textbooks or something like that".

4.2.3: Technological Barriers to Wind Energy Development in NL

The vast majority of participants believed that "technological" issues were not affecting the rate of wind energy development in the province – only 5 expert participants (29%) believed this was a significant barrier **(Fig. 4.2).** Despite this, several themes emerged in this category, including: (1) wind intermittency: required backup, acceptable penetration levels, and energy storage, (2) icing of turbines in harsh environments, (3) spilt energy: implications of existing electrical system, and (4) other technical concerns.

Wind Intermittency: Required Backup, Acceptable Penetration Levels, and Energy Storage

Many respondents acknowledged that naturally, wind is intermittent, which leads to technical and economic limitations when used as a source of energy. As an ENGO representative stated, "If the wind does not blow, you won't have any power". Thus, if wind energy is to be deployed on a large-scale, it requires a backup generation source, or some form of energy storage. According to an academic participant, adding additional generation sources or energy storage technologies to the existing system "is an additional cost that will introduce complexity into the power system operation".

Participants generally agreed that as a result of intermittency, "wind energy cannot serve as a base load"; and that it must be backed up by a dispatchable source, such as hydroelectricity, or thermal (i.e. hydro, coal, oil, or natural gas) generation. There was significant debate regarding the level of wind energy an isolated system can absorb without technical consequences. Some participants were more conservative with regards to feasible wind penetration levels, for example, a government representative stated, “10% wind energy is a rule of thumb, although it does not always work”. Other participants were more optimistic, a private sector actor stated, “you need to start discussing energy storage when you are reaching 35% of wind penetration on the grid”. Other participants were somewhere in between, a private sector actor stated “the maximum we could ever penetrate [thermal generation systems] … would be 20%”. Participants explained that moving beyond low penetration levels would require significant upgrades to the existing electrical system, including specialized wind forecasting, retrofitted generators with higher ramp grades, increased regulation, and improved load management systems.

Participants agreed that high levels of wind energy would require some form of energy storage. Many forms of energy storage were discussed including large-scale hydro reservoir storage, pumped hydro storage, hydrogen storage, as well as different types of batteries and fuel cells. Participants generally agreed that for small-scale systems “battery storage is a well-established technology that is not a barrier”. However, for large-scale systems, participants generally agreed that hydroelectric reservoirs and pumped hydro were the only technically and economically feasible storage options at this time. The ability to effectively store significant amounts of energy represents a technical barrier to large-scale wind energy applications.

Icing of Turbines in Harsh Environments

Participants generally agreed that icing is a site-specific issue in the province. Icing essentially refers to the buildup of ice on turbine blades, which decreases the efficiency of the system and poses risks to the continued operation of the turbine. As an academic participant stated, "In this province, we have a hostile environment, where icing is a big issue".

A private sector participant referred to a Pan-Canadian wind energy study, where a rough estimate of average energy losses from icing across Canada was 8%. For comparison, a utility representative referred to a wind-heat map that was produced for the province; the study found that 10-15% of energy was lost due to icing in particular regions of the province; significant icing regions were identified as the Bonavista Peninsula and the northeast Avalon.

There has been some disagreement over the extent icing is an issue in Labrador. One government participant stated, "We did some testing in Labrador… and the ice collection data looked pretty scary", while a utility representative stated, "Icing is generally not an issue [in Labrador]. Icing occurs on transmissions lines from freeze and thaw [processes]…In Labrador, when it gets cold, it stays cold. So the freeze-thaw scenarios, and the icing events – we do not have much of an issue".

Other participants believed that icing was not a significant issue due to the availability of technological solutions. As a private sector respondent stated, "Icing is probably one of the least worries when it comes to wind turbine towers – because you have [technology]… such as vibration, or electronics, that shake the ice off". Another private sector participant stated that with state-of-the-art technology, wind turbines will only shut down [from icing] when temperatures reach below -30ºC.

While it was generally acknowledged that icing is a technological issue, it is only a significant barrier in some regions of the province. With proper siting of turbines, and modern technology, the issue of icing may be overcome. As a private sector respondent stated, …

> "Icing is a problem that is a bit more specific to Newfoundland, because of the Atlantic air front and the very humid condition… but this is just another factor that you include in [system planning]. It is a small barrier, but you can account for it in [system planning]".

Spilt Energy: Implications of the Existing Electrical System

A number of participants explained that the potential for large-scale wind energy development in the province is affected by technical limitations of the current power generation system. As a utility representative stated, "Our electricity system is completely isolated from the rest of the North American grid; there is only so much wind that can be absorbed into our system before we hit technical and economic constraints". The primary technical constraint for integrating additional wind energy onto the provincial grid is termed spilt energy or essentially wasted energy at the province's existing hydroelectric facilities. As a utility representative explained:

> "When you start adding more wind beyond the amounts we already have on our system… we increase the likelihood of spill at our existing hydro dams". So if we add a kilowatt hour of wind, and we spill the equivalent of a kilowatt hour of water, we have not made any positive impact on the electricity system".

The participant further added: "It's a zero sum game… [energy] just goes over the dam because we can only store so much water. Electricity is one of those things, it must be consumed instantly as produced… [when it spills] we have paid for something we cannot utilize".

A number of participants referred to a technical document created by the province's Crown Energy Corporation entitled "*An Assessment of Limitations for Non-Dispatchable Generation on the Newfoundland Island System*" (NL Hydro, 2004)[2]. As a government

[2] In 2012, the Crown Energy Corporation commissioned an independent consultant to review their previous technical analysis, and to assess how much additional wind power could be added, economically and technically to the system. The study concluded that by 2035, approximately 300MW of additional

representative explained, “It set a cap at 80MW, and it explained that if you go above 80MW of wind on the island… you are spilling water when you need to be storing water”. The participant also added “what is the point of generating a megawatt hour of wind power, when you just spilled a megawatt hour of hydro power over the reservoir?”

Other Technical Concerns:

Maturity/Reliability of Technology:

A small number of participants expressed concerns that wind turbine technology was underdeveloped and unreliable. As a community group representative stated, “[wind energy] is underdeveloped, it is like any technology that has not been used”. A government representative stated that “there is a lot of uncertainty, and a lot of mistrust [regarding wind technology]”.

Despite these concerns, a large majority of participants held an opposing position. As a utility representative stated, “Wind technology has been advancing in leaps and bounds... it is what you would call a fairly mature technology”. For example, a private sector actor stated: “In early 2000, we had 137MW of installed [wind energy] capacity. We now have 10,000MW in Canada. The technology is well integrated into all of the electricity grid (sic) across the country”. An ENGO representative added, “Wind is obviously a mature

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wind generation would be feasible. However, the results of this study are now in question as NL Hydro (2012) states “additional wind was not incorporated in the Interconnected Island case. However, wind could be built for export and this option will be analyzed at a later date” (p. 17).

technology, there is (sic) thousands of megawatts of wind power in service around North America. There is nothing experimental about wind power".

Strength of Wind Speeds:

Some participants expressed concerns that wind speeds in the province were simply too strong for commercially available wind turbines. As a government representative stated, "We have too much wind"; similarly, an academic participant stated: "We have a harsh environment… when the wind blows strong and gusty all the time, it may not be appropriate for technology in terms of turbines that have been developed".

Despite these concerns, the majority of participants believed that this was not a significant issue. For example, an academic participant stated: "Wind speeds are not too strong [in NL]; our average wind speed is about 6.25 m/s. If you look at Scotland, their annual average is 7.5 m/s, so our wind speeds are not that high" later adding: "When it comes to variance [or gustiness], that is also not significant… commercially available wind turbines can easily handle up to 30 or 45 m/s, with survival rates of 50 m/s – so this is not an issue".

4.2.4: Economic Barriers to Wind Energy Development in NL

A majority of participants (65%) believed that "economic" issues were affecting the rate of wind energy development in the province **(Figure 4.2)**. The main themes which emerged in this category included: (1) cost competitiveness of wind energy, (2) insufficient provincial demand – limited access to export markets, (3) existing monopoly in electricity market, and (4) fossil fuel externalities and subsidies.

Cost Competitiveness of Wind Energy

The cost competitiveness of wind energy compared to alternative generation sources was by far the most prevalent area of discussion among participants within the economic category. If wind energy is more expensive than other generation sources, this represents a clear economic barrier, as wind energy would not be able to compete on the market. **Table 4.3** details cost estimates of generation sources as provided by participants for comparison. While the figures provided here are only estimates – albeit informed by expert opinion - a number of key lessons can be drawn from this data.

Generation Source	Description	Low Cost Estimate	High Cost Estimate
Onshore Utility-Scale Wind Energy	Existing 27MW projects in St. Lawrence & Fermeuse	$0.07-0.08/kwh	$0.12-0.14/kWh
Thermal Generation	490MW generating station in Holyrood	>$.10/kWh (low oil prices)	$0.16-0.19/kWh (high oil prices)
Large Scale Hydroelectricity	600MW hydro station in Bay d'Espoir	$0.02/kWh	$0.045/kWh
Large Scale Hydroelectricity	824MW hydro project under development (Muskrat Falls)	$0.08/kWh	$0.15-.0165/kWh
Large Scale Hydroelectricity	5,428MW generating station in Churchill Falls, Labrador	$0.002/kWh	N/A
Isolated Diesel Plants	Various remote communities throughout province	N/A	>$1.00/kWh
Small-Scale Wind Energy	Pilot project in Ramea	$.10-.15/kWh	$0.17-0.18/kWh
Natural Gas	Spot market price	$0.03-0.04/kWh	$0.06/kWh

Table 4.3: Cost of Electricity Generation by Source in NL

Natural Gas & Spot Market Prices as a Barrier to Wind Energy:

Participants generally agreed that competition with natural gas generation and spot market prices in the United States were economic barriers for the development and export of wind energy in the province. As shown in **Table 4.3**, natural gas can be purchased on the spot market for as little as $.03/kWh, compared to $0.07/kWh at the province's existing wind farms. As stated by a government representative, "If natural gas is priced at four dollars per million (sic) btu's (British thermal units) [approximately $0.04/kwh], you may never see the development of any more wind or hydro [in the province], beyond Muskrat Falls".

Participants explained that an additional disadvantage of selling wind energy onto the spot market, is that wind energy has to be consumed when it is produced – which may mean receiving unfavourable prices for exported electricity. As a utility representative explained, "You take the spot market prices whenever the [wind] turbine is turning", later adding: "With hydro projects... when market prices are going up, we turbine the energy. When the market prices are down, we hold it back. We do not have that ability with wind projects, you are a price-taker – period".

Existing Hydroelectric Facilities as a Barrier to Wind Energy: Bay d'Espoir and Churchill Falls

According to the data collected from participants, wind energy cannot compete with existing hydroelectric facilities in the province. Even if wind energy could be produced below $0.07/kWh, it is still magnitudes above the cost of generation at existing hydroelectric facilities. Participants explained that the province's largest hydroelectric generation stations were built in the 1960's and 70's; construction costs are largely paid for, and only minimal operational costs now have to be covered. As stated by a private-sector participant, "The existing hydroelectric power in Newfoundland is just about free".

As an ENGO group participant explained, “Wind energy is not cost competitive with the Upper Churchill; I do not think anybody in the country is cost competitive with that development”.

Cost Competitiveness with Thermal & Diesel Generation in the Province

Participants generally agreed that wind energy is cost competitive with the Holyrood Thermal Generating Station on the province’s main electricity grid. According to participants, when oil prices were high, it cost approximately $0.16-0.19/kWh to produce electricity at Holyrood. Even in a low oil price environment – participants stated that it cost more than $0.10/kWh to produce thermal-based electricity. In comparison, energy from the province’s existing wind farms costs approximately $0.07-0.08/kWh. As a government representative stated, “The economics are (sic) pretty clear; wind is cheaper than Holyrood or oil”.

Participants typically thought that small-scale wind energy applications can be cost-competitive with diesel-plants in the province’s remote communities. As an academic participant explained, “In remote communities, the cost of generation is very high, it is more than $1.00/kWh… this is due to high costs of [fuel] transportation, and maintenance of diesel plants”; this respondent also noted that “If they installed wind turbines, that would reduce their [diesel] equipment – then it will make [economic] sense”. For comparison, participants believed small-scale wind energy projects could produce electricity for less than \$.20/kWh, and large-scale wind energy projects cost less than \$.08/kWh. Participants generally agreed that integrating wind energy, solar power, or small-scale hydroelectricity, would be a cost competitive method of displacing some level of diesel fuel in off-grid communities.

Cost Competitiveness with Other Renewables:

While there was some level of debate, many participants agreed that wind energy is cost competitive with other forms of newly-built renewable energy generation plants. As a utility representative stated, “It is cost competitive with other forms of renewable energy; solar, geothermal, biomass, hydro – it is, it can be cost competitive”. This is attributed to the high quality of the province’s wind resources.

The main area of debate among participants was whether or not wind energy is cost-competitive with newly-built hydroelectricity. For example, Muskrat Falls was originally estimated to cost \$0.08/kWh, roughly the same cost as electricity from existing provincial wind farms. However, hydroelectricity has the advantage of being a dispatchable energy source that can fetch higher prices on spot markets, and has lower integration costs at high levels of penetration. Despite the rising costs of Muskrat Falls – now in the range of \$0.15-\$0.165/kWh – many participants believed these benefits made it a more economically attractive option than large-scale wind energy.

Insufficient Provincial Demand - Limited Access to Export Markets

Participants identified two interrelated economic barriers: insufficient demand for electricity in the province and limited access to export markets for any future wind energy developments. As a private sector actor stated, “A key economic barrier for wind is load, or electricity demand”. If there is no demand for electricity in the province, participants suggested it is uneconomic to build additional wind generation.

Because there is limited demand for additional utility-scale wind generation in the province, any new wind developments would have to be built for export. As an academic participant stated, “The best way to ensure the economic value of a wind project is to be able to guarantee that you will reach a market when you are producing”, later adding “if the local market is too small to absorb your power... then you have to access a wider market”.

Currently, the province’s electricity system is isolated and has no access to wider export markets – participants believed that this is a significant economic barrier to the development of wind energy. As an academic participant stated, “The key barrier to wind power in Newfoundland… is access to interconnections that will enable you to connect to markets across the continent”. Participants acknowledged that building transmission lines was expensive and would affect the economics of any wind development; as a private-sector actor stated, “Transmission costs money; it is very expensive, especially for an island like Newfoundland”.

There was a level of disagreement regarding how the Maritime Link being built as part of the Muskrat Falls project would change the prospects for wind energy development in the province. For example, a utility representative stated, “The Muskrat Falls project and the associated transmission… will interconnect the island of Newfoundland with the North American grid… which will change the business case for wind quite dramatically”. Conversely, an academic participant argued that of the 500 MW capacity on the Maritime Link, approximately 340 MW is already dedicated to Nova Scotia and the broader spot market, meaning there is limited spare capacity for the development of wind energy.

Existing Monopoly in Electricity Market

Participants explained that wind energy developers in the province face barriers due to the monopolistic nature of the electricity generation and distribution sectors in the province. If wind producers cannot compete in the marketplace, this is a barrier to any future wind energy developments. Although many participants expressed that this is a political barrier due to the existing regulations, it has clear economic implications.

An academic participant explained that opening up the market place to competition would not only allow for wind energy producers to compete against existing generation, but it may offer potential for investment in additional transmission. As a private sector respondent stated, “With the [monopolistic] restrictions in place – our hands are tied. We are not allowed to compete, innovate, or find a better way to do things”.

Fossil Fuel Subsidies & Externalities

A number of participants argued that existing fossil fuel subsidies and externalities represent a barrier to the development of wind energy in the province, as these external costs affect the competitiveness of renewable energy sources. As an ENGO representative stated “We need to bring wind energy and other renewables onto a level playing field with fossil fuels, which benefit from billions of dollars of subsides annually. Fossil fuels also benefit from existing infrastructure which is predicated on their use”. Some participants also expressed concerns that the combustion of fossil fuels imposes public health costs.

A primary area of concern were subsidies that support diesel plants and electricity generation for remote communities. A utility representative explained that in some jurisdictions across Canada, ratepayers and governments are subsidizing electricity rates from diesel plants to the order of 90-95%[3]. While these subsidies have been developed to lower electricity rates for consumers who otherwise could not afford the true costs,

[3] For example, in 2003, diesel customers in the province paid 26% of electricity costs, while rural interconnected customers paid 64% of actual costs (Department of Mines and Energy, 2003). Furthermore, other retail consumers of electricity in the province subsidized the cost of rural electricity generation by $49.3 million in 2012, and an estimated $60.7 million in 2013 (Feehan, 2014).

participants believed that the subsidies distort the cost of electricity generation from fossil fuels, and negatively affect the competitiveness of renewable energy sources.

4.2.5: Social Barriers to Wind Energy Development in NL

The vast majority of participants (76%) believed that "social" issues were not affecting the rate of wind energy development in the province **(Figure 4.2)**. Themes which emerged in this category included (1) the NIMBY phenomenon, (2) noise impacts, (3) avian mortality, and (4) aesthetic impacts.

NIMBY Phenomenon

A small number of participants expressed concern that wind energy projects may face some form of 'NIMBY' opposition if developed close to residential areas in the province. As an academic participant stated: "Look what happens with cell phone towers [in the province] – with opposition to radiation, magnetism, and noise. If it is close to a relatively populated area, you will find the same reaction to a wind farm".

Despite these concerns, the vast majority of participants believed the NIMBYism was not an issue affecting wind energy development in the province. A government representative explained that community support of wind energy has been very high, and that municipalities have desired greater wind development; the participant stated "That is the opposite of NIMBYism, that's IMBYism [in my back yard-ism]". Furthermore, a wind developer in the province stated, “[NIMBYism] is almost opposite in Newfoundland. We [have] only received positive support”.

Participants generally agreed that due to the high levels of Crown land available for development, wind energy projects do not elicit much opposition in the province. As a government representative stated, “There is (sic) tons of Crown land out there… so [wind energy] is not encroaching on people. Support for wind energy is very high”.

Noise Impacts

Some participants expressed concerns about the noise that wind turbines generate, and that this may contribute to some level of community opposition. As an academic explained, “Wind turbines generate noise - from the blades, from the drive, it could be transformer hum… depending on the size of the turbine, if you are close to it on a windy day, noise levels could be 60-70 decibels or higher”. A community group representative captured the sentiment when they stated “Wind turbines do make noise; I would not want to live across the street from one”.

For example, an academic participant described a wind turbine pilot project that took place at a postsecondary institution in the province; they stated, “It was installed on campus, very close to nearby houses. There was a noise issue, neighbors complained, and the wind turbine was ultimately removed and installed at another site”.

Overall, participants believed that noise was not a significant barrier to the development of wind, as noise issues can generally be overcome with proper technology and siting of turbines. As explained by an academic participant, "Large wind turbines should be at least two kilometers away from people's homes [to avoid noise impacts]". For example, a government representative explained that in Ramea, which hosts a small-scale wind energy pilot project, "I have never heard a negative comment about the wind turbines… they are actually right next to town";… they later contrasted, "I mean, you have got a diesel generator that is humming all the time; it is a lot louder than the wind turbines".

Avian Mortality

A small number of participants acknowledged that wind turbines may have detrimental impacts on wildlife, as stated by a private-sector participant: "[if wind energy development proceeds] people might have a concern – is this going to hurt migrating birds?"

Other participants argued that wind turbines are not a major factor causing avian mortality. As stated by a private-sector participant, "Wind turbines are a very small threat to bird mortality; if you look at power lines – they are more of a threat to any kind of a bird flying around".

Aesthetic Impacts

A small number of participants stated that people may oppose the development of wind energy in the province due to aesthetic impacts on the landscape. As a community group representative stated, "I think there's a certain sociological dimension to opposition to wind turbines, due to the fact that they often go up in places that do not see much industrial development, because they are often pretty postcard places".

4.2.6: Political Barriers to Wind Energy Development in NL

The vast majority of participants (71%) believed that "political" issues were affecting the rate of wind energy development in the province **(Figure 4.2)**. Themes which emerged in this category included (1) institutional barriers, (2) lack of government policy, targets, and political will, (3) governmental preoccupation with Muskrat Falls, oil & gas development, (4) inadequate public consultation regarding energy policy decisions, (5) governmental preference for continuation of status quo, and (6) legislative barriers.

Institutional Barriers

A primary area of discussion among participants was related to the Crown Energy Corporation (CEC) and how it has affected the rate of wind energy development in the province. In order to capture the range of debate, this topic has been broken down into subcategories including (1) the mandate of the CEC, (2) the role of Nalcor: facilitating vs. constraining wind energy development, and (3) the use of least-cost generation planning.

The Mandate of the Crown Energy Corporation

Some participants believed that due to governmental mandates, public utilities are inherently conservative institutions which may prevent them from adopting new technologies such as wind energy. As stated by a private sector respondent …

> "By their nature, utilities are very conservative entities; their role is to make sure that the lights come on every time we need them, which is great and necessary. Although sometimes, we might have to push our utilities to be more cutting edge in terms of new technology and to bring our electricity system into the 21st century".

A wind developer in the province reinforced this point, as they stated:

> "I think Nalcor has constrained wind energy development, but only on the basis of their own mandate. They have not objected to [wind energy] just for the sake of objecting to the technology… instead, they have not supported wind energy because of the objective given to them, which is to guarantee power for the island for the longest period of time without much variation in terms of cost".

The Role of Crown Energy Corporations: Facilitating vs. Constraining Wind Energy Development

A significant area of debate among participants was whether or not the CEC has helped to facilitate, or constrain wind energy development in the province to date. Even if the utility is only perceived as barrier to wind energy development by others in the province, this may hinder other key actors (academics, ENGO's, the private sector) from collaborating with the CEC to pursue any type of wind energy development – including research, development, and exploring future opportunities.

A number of participants believed that the CEC was actively supporting wind energy development. As a utility representative stated, "As a Crown Energy Corporation – we are one of the ones who went forward and actually solicited wind development here in the province. We have stepped up, along with ACOA [Atlantic Canada Opportunities Agency]… and we are spending significant capital on advancing [wind energy] research". An academic participant added, "The Crown Energy Corporation is spending money, showing commitment, and demonstrating interest – for example, they have a demonstration project in Ramea".

Conversely, many participants believed that Nalcor/NL Hydro were constraining wind energy development in the province. As an ENGO representative stated, "It is very clear, it is unfortunate, [the Crown Energy] Corporation has constrained [wind energy development] in the province" … later adding, "It is impossible to get any information out of them [about wind energy]". A private-sector respondent stated, "In this province, the Crown Corporations were set up to develop energy – and that does not include wind power".

The Use of Least Cost Generation Planning

A number of participants explained that the CEC uses 'least cost generation planning' when making decisions of which generation sources will be developed in the province. Because 'least cost generation planning' is primarily concerned with capital costs and profitability, and does not consider economic externalities such as environmental and social implications of energy sources, participants believed that this may represent a barrier to renewable energy sources such as wind energy (which typically have high capital costs but low external costs).

Lack of Government Policy, Targets, and Political Will to Support Wind Energy

A majority of participants – from all target groups (academia, ENGOs, government, and the private-sector) - believed that there is a lack of government policy and political will to support the development of wind energy in the province. For example, a government participant stated that "wind energy is not an issue for government… no one is knocking on our door about wind generation". An ENGO representative stated: "In NL, policy development and goal-setting around wind energy, is fairly non-existent". A utility representative stated: "In the absence of a clear policy on [net-metering], the Crown Energy Corporation has probably held back on wind energy".

Participants generally believed that existing targets established by government are now inadequate. As an academic participant stated, "In the initial energy plan, they imposed a limit of 80MW of wind energy. They have since completed full detailed studies, and they simulated that 300-400MW of wind energy can easily be injected into the grid". A government participant also explained, "The Crown Energy Corporation refreshed their previous study… [they found] closer to 200MW [could now be integrated] on the island of Newfoundland – which was close to 10% penetration level at the time". Despite the new information revealing the potential for additional development, the targets for wind energy development have not been updated.

Participants argued that in jurisdictions that have been successful in developing wind energy, the industry has been supported by various forms of government policy and targets. As a private sector participant stated, "You need regulated, binding targets in terms of wind penetration – or renewable penetration of the grid. Targets like we have in Quebec, the 2020 target in Europe, the broader support of carbon pricing… these are necessary tools to level the playing field [with fossil fuels]". Another private sector participant argued: "Our province is the only jurisdiction in Canada that does not have either a feed-in-tariff, a net-metering policy, or some other policy tool to get [renewable] energy onto the grid".

There was a high level of disagreement regarding whether or not the province's newly developed net-metering policy will support wind energy development in the province. As an academic participant stated, "[government policy] is favourable… in the sense that they introduced net-metering… there will be some new installations". Conversely, a government participant stated, "net metering is going to make absolutely no difference to electricity in the province". An academic participant explained that the net-metering policy will only allow for five megawatts of new development, they stated "that will be a barrier, because 5MW is nothing".

Governmental Preoccupation with Muskrat Falls, Oil & Gas Development

The majority of participants believed that the provincial government's decision to build Muskrat Falls represents a barrier to wind energy development in the province. Participants generally believed that the development of any other source of energy in the province has been impeded due to government's preoccupation with the project. As a government representative stated, "Nalcor will look at wind energy after Muskrat is built, everything is currently dedicated to Muskrat Falls". A utility representative stated: "We have a mandate to do economic development of wind energy, but right now, the focus is clearly on executing projects that we already have in hand". An academic participant explained that “all government resources, all policies, are focused on one project. It got approved, work is being done, and now they are not willing to discuss any other [energy] sources”.

Many participants believed that once Muskrat Falls is completed, there will be no need for additional power sources in the province. As a government representative stated, “We cannot add more wind now… because we decided to build Muskrat”. A private sector participant explained that when the Fermeuse Wind Farm applied to double the size of their operation – from 27 to 54MW – following power outages and reliability issues in 2014, “the request was turned down… because the province decided to develop the Lower Churchill, and there was no need for power from the Fermeuse Wind Project”.

A small number of participants expressed a contrary opinion, and argued that the decision to build Muskrat Falls actually represents a major opportunity for the development of wind energy in the province. As a government participant stated, “By bringing Muskrat online, as well as the associated transmission line to the Maritimes, that brings on a lot more possibilities to develop large-scale wind for export; our policy has been supportive [of wind energy]”.

A number of participants also believed that government was too preoccupied with oil and gas development to concentrate on other energy sources. As an ENGO representative stated, “Offshore oil and gas development really preoccupies the political system”, and later adding "within that context, there has just been no room for other renewables to be given any sort of consideration". An academic participant explained that most research funding has been directed towards oil development; they stated, "With all the funding going into petroleum research, there was a bit of a pull [away from wind energy] there".

Inadequate Public Consultation Regarding Energy Policy Decisions

Most participants believed that the provincial government has not conducted adequate consultation with regards to energy policy decisions. As an ENGO representative stated, "Public consultation is not a big priority with the Newfoundland government… that is one of [our] impediments to innovation – we do not have [proper] consultations with people who are experts in the field". A private-sector participant stated, "There is no consultation – they [the provincial government] go out of their way not to consult", later adding, "there is a broken consultation process, [they have] a viewpoint, that we [the provincial government] know best".

In particular, a number of participants argued that wind energy was given inadequate consideration as an alternative to Muskrat Falls – during Public Utility Board (PUB) hearings - when determining the 'least cost option' to meet the province's future energy needs.

An ENGO representative argued…

> "When the Public Utilities Board was asked to take a reference study into the Lower Churchill Project… there were only two [alternatives] put on the table for consideration. One was interconnection with Muskrat Falls, [and the other was] the continuation of thermal and small hydro development. There was very little attention given to wind [during the study]".

The participant also added that "the Public Utilities Board did not have any evidence presented to it on wind energy".

Governmental Preference for Continuation of Status Quo

A number of participants argued that there is a general preference within the government, when it comes to energy sources, to continue with the status quo; as a result of this, additional renewable technologies are often not considered in system planning. As an ENGO representative stated, "We do not have a culture of innovation, we have a culture of tradition. If something is not broken - do not try to fix it, and do not try to make it better". A government participant stated: "It is a cultural thing, [wind energy] has never been contemplated here. Government is behind the curve; it does not lead the curve".

Some participants argued that the province has traditionally relied on hydroelectricity, and that there is little need to move away from this. As a government participant stated, "Newfoundland and Labrador is hydro driven, it always has been", also adding:

"hydroelectricity in the province started with the paper mills, and we have been there ever since. We have got hydro; why do we need anything else?" A private-sector respondent argued that because the province already uses renewable energy resources, it is not necessarily negative that new technologies have not been developed. Furthermore, a government participant explained that in the province's remote communities, there is already an existing diesel system – so there is little need to provide new generation sources.

Legislative Barriers - Bill 61

Participants generally believed that existing legislation has prevented the development of wind energy in the province. A number of participants referred specifically to *Bill 61*, which prohibits any private actor from generating or distributing energy via the provincial grid. As a private sector respondent characterized the legislation, "Grid tied power is illegal in Newfoundland".

An additional private sector actor stated, "We have legislation in place that says you can not [develop wind energy]. [The bill] essentially says that there will only be one producer of power in the province".

A wind developer in the province explained the negative impacts of the legislation…

> "In the rest of North America, power production is a competitive undertaking…. There is competition between various players to produce electricity at the lowest price possible. In Newfoundland, there is no competition – it is a monopoly that Nalcor has and controls all decisions related to energy".

4.3: Potential Economic, Environmental, and Societal Benefits of Wind Energy Development in Newfoundland and Labrador

While the expert interviews were primarily concentrated on identifying barriers to renewable energy development – with a focus on wind power – in the province, participants were also asked to consider the current and potential economic, environmental, and societal benefits of wind energy development in a provincial context. This section reports what expert participants perceived as the primary benefits of wind energy development in NL; this section addresses the secondary research question:

2) What are the primary benefits of wind energy development in a provincial context, as identified by the respondents?

Table 4.4 provides an overview of the primary economic, environmental, and societal benefits of wind energy development in NL, as determined by expert elicitation. The benefits are presented in a hierarchical order according to prevalence and frequency of discussion in coded interview transcripts.

Economic	Environmental	Societal
1) Streamlined Development of High Quality Wind Resource	1) Reduction of GHG Emissions – Displacement of Diesel-Generation In Remote Communities	1) High Social Acceptance
2) Regional & Local Economic Activity – Economic Diversification	2) Complementary to Existing Hydro Resource	2) Distributed Energy Sources: Increased Diversity, Reliability of System
3) Fuel Savings at Holyrood Thermal Generating Station	3) Preferred Energy Source	3) Increased Awareness of Climate Change
4) Export Potential		
5) Economical Source of Energy – Electricity Rate Stabilization		
6) Household Financial Savings & Increased Business Competitiveness		
7) Streamlined Development		

Table 4.4: Primary Benefits of Wind Energy Development in NL

4.3.1: Economic Benefits of Wind Energy Development in NL

As demonstrated in **Table 4.1**, the majority of themes developed in data analysis were economic in nature. The primary economic themes included (1) development of a high quality wind resource, (2) local economic activity – economic diversification, (3) fuel savings at Holyrood Thermal Generating Station, (4) export potential, (5) economical source of energy – electricity rate stabilization, (6) household financial savings & increased business competitiveness, and (7) streamlined development.

(1) At least 12 expert participants (71%) in the study recognized and promoted the significant potential for wind energy development in NL based on the quality of the province's wind resources. A typical response was: "The potential for wind energy in this province is immense, and the opportunity is definitely there". A number of participants referenced the Provincial Energy Strategy (Government of NL, 2007) which identifies NL as having amongst the strongest potential for wind energy development of any jurisdiction in North America. As one utility representative stated. "If you look at the best [wind energy] locations in the rest of North America, those are the worst locations in Newfoundland".

Many participants supported NL's wind energy potential in terms of high capacity factors[4]. Multiple participants stated that wind energy projects in NL have capacity factors in the range of 40-45%; according to one participant, the St. Lawrence wind farm was recently rated as "the highest producing wind farm in the country". According to a utility representative, with modern technology in NL's wind environment, capacity factors would likely reach or exceed 50%. According to participants, wind energy projects are proceeding across Canada with capacity factors ranging from 20-25%, this means that NL would get twice as much energy from a wind project per unit of

[4] Capacity factor is the amount of energy output in a year from a turbine – divided by the amount of energy output by that turbine in a hypothetical situation where it was operated continuously at rated capacity.

investment compared to these projects[5]. According to a government representative, "If you get a 40% capacity factor versus 25%, you are dropping the cost per unit generated and put onto the grid".

Furthermore, a number of participants cited the streamlined development process of wind energy as a primary economic benefit. As one private sector actor stated, "Wind and other renewables can be great, reliant, installed incrementally – as we need them… and built on time, and can be built very rapidly". Participants generally agreed that wind projects are quick to licence and build compared to other energy sources, or large-scale generation projects.

(2) Many participants promoted wind energy development in terms of increased regional and local economic activity. Potential benefits included increased capital investment, municipal and rural revenue generation, wind rights landowner payments, and job creation. A typical response from participants was: "Renewable and wind [energy] can be a tremendous tool to develop regional economies and to bring local economic benefits". A utility representative added, "Municipalities see it as rural development, they see it as a tax base, they see it as jobs".

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[5] This is true if all other construction, operation, and maintenance costs are considered equal. Some of the costs differ throughout Canada due to existing industrial bases, availability of labour, etc. – however, turbine costs are mostly equal throughout the country.

A number of participants in the study promoted the development of a wind energy industry as a form of economic diversification. As one academic participant stated, “When you develop wind, it allows various parts of the province to benefit in terms of another source of economic activity, and through economic diversification as well”. Participants generally believed that developing wind energy could create other supporting businesses that are related to renewable energy. One participant drew on the example of the wind energy sector in Ontario, stating: “In London, they have fiberglass or composite wind turbines, this allowed them to build a composite industry”. Participants also acknowledged that rural areas of the province could benefit from economic diversification; an academic participant stated, “As long as the wind is blowing, you can have economic diversification in other parts of the province as well”.

(3) Many research participants argued that the central benefit of developing wind energy on the Island of Newfoundland was displacing consumption of expensive fossil fuel generation at the Holyrood Thermal Generating Station. As one government representative stated, “When we talk about the island’s wind farms, when they are generating, they are saving oil at Holyrood”. According to DNR (2006), the province’s existing wind farms currently offset 300,000 barrels of oil at Holyrood per year. Compared to the cost of burning oil at Holyrood, existing wind farms save consumers $8 million annually over the 20-year life of their contract (NL Hydro, n.d.).

(4) A number of research participants promoted wind energy as an export opportunity. As one academic participant stated, "Wind can be helpful in terms of allowing you to export [electricity] to other markets that are dependent on thermal". A private sector actor stated, "If there was an export to the mainland at a good price, installing on the grid of 300-400MW, and selling some of that to the mainland is possible". Participants of the study identified the Maritime Provinces, as well as the north east United States as the primary export markets of significant potential.

(5) Respondents of the study generally promoted wind power as an economical, cost-effective form of electricity generation. As one government participant stated, "We have got two wind farms, and they are cheap. It's not like we had to go out and subsidize them... they are cheaper than the other options".

Members of ENGOs expressed concern around increasing electricity rates in the province, especially for residents on fixed incomes[6]. A non-profit representative stated, "We are not going to be able to afford the prices that Nalcor is going to have to charge for hydroelectricity power". A number of participants promoted wind energy based on its potential to stabilize electricity rates. As one utility representative stated, "[Wind has] direct economic benefits to electricity consumers here in the province through generally

[6] Documents on file with the province's Public Utilities Board suggest average residential electricity rates will increase to 19.8 cents per kWh by 2020 – a 53 percent increase from current rates (Fitzpatrick, 2016). Participants suggest that wind energy may play a role in helping to stabilize increasing electricity rates.

lower electricity bills. Or a positive impact towards reducing the overall cost of electricity systems".

Participants generally acknowledged that the price of wind energy remains constant because there are no fuel inputs once a wind project is constructed. As one private sector actor stated, "It's a hedge against price volatility. The price of wind is the same [with the signing of a power purchase agreement], it will be the same today as it will be in 20 years". A participant drew on the example of PUBNICO, the first major wind farm installed in Nova Scotia in 2007. The facility reached rate parity with other forms of electricity generation at $0.07 per kWh in 2011. The participant stated, "[The price] is going to stay there for 25 years, which is incredible. Whereas, who knows where the cost of [thermal generation] will go?".

(6) Participants acknowledged that the installation of small-scale wind energy systems on residential or commercial properties may have economic benefits for consumers[7]. According to a private sector participant, "For residential or commercial [users], to build their own power system, with their own money, it is the cheapest way you could ever go". Participants generally acknowledged that "net metering changes the economics of those [small-scale wind energy] systems. It makes it more attractive for the consumer to purchase the system". Net metering policies allow retail electricity customers to be

[7] For example, 44 states throughout America have some form of net metering policy, and each state differs in policy specifics. In Arizona, residential consumers with net metering save approximately $1,260 per year on their electricity bills, while medium commercial enterprises save $20,173 (Navigant, 2012).

compensated by their electric utility for the excess electricity they produce with small-scale renewable energy systems.

4.3.2: Environmental Benefits of Wind Energy Development in NL

The following section will describe environmental benefits themes that were developed during the analysis of data. The primary environmental themes developed included (1) Reduction of greenhouse gas emissions: displacement of diesel-generation in remote communities, (2) complementarity to existing hydro resources, and (3) preferred energy source.

(1) Reduction of greenhouse gas emissions was a central environmental benefit of wind energy development identified by respondents. As stated by an academic participant, "[With wind energy] you burn less fossil fuels, and obviously greenhouse gases would be reduced. Not only here, but where we are exporting to… otherwise they would be burning coal, thermal, or diesel – so it reduces greenhouse gases here and elsewhere". Participants believed that expanding wind energy on a utility-scale[8], as well as in isolated communities[9], would contribute to further reductions in GHG emissions.

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[8] For example, in 2010, NL emitted 8.9 million tonnes of greenhouse gas emissions. Power generation accounted for 8% of this total (Office of Climate Change and Energy Efficiency, n.d.). The province's two operating utility-scale wind farms reduce GHG emissions by approximately 140,000 tonnes annually, by displacing oil-fired electricity (Office of Climate Change and Energy Efficiency, 2011).

[9]The wind-hydrogen-diesel pilot project in Ramea displaces 425,000 kWh of diesel energy production per year, or approximately 120,000 litres in fuel. In total, the project reduces 320 tonnes per year of carbon dioxide emissions, 6.8 tonnes of nitrogen oxide, and 0.43 tonnes of sulphur dioxide (Lacroix, 2009). There

Participants believed that wind energy had the potential for improving sustainability in the province's remote communities[10]. As one non-profit representative stated, "All of our coastal communities are diesel; wind energy could be developed in each and every community". A private sector actor suggested that wind energy in these communities would be a cost effective solution to reliance on diesel; they stated, "Their current cost of generation is very high; it is more than a dollar per kilowatt hour". Developing wind energy in these communities, could decrease reliance on diesel fuel and create financial savings for consumers.

(2) Participants supported wind energy development due to its benefits for the province's existing energy system. A government representative stated, "[Wind energy] allows us to generate less hydro, and store that water for a time when we need to offset fuel". As stated by an academic participant, "The beauty of large water reservoirs is that they can be used as your storage battery of energy; a beautiful coupling of wind energy is to hydroelectric reservoirs".

are 21 remote isolated communities throughout the province that rely exclusively on diesel generation (Jones, 2010).

[10] The province's Crown Energy Corporation operates 25 diesel-plants throughout the province in remote communities not connected to the energy grid. The province's diesel plants have a total generating capacity of approximately 55MW (Keough, 2013.); combined, the plants burn an estimated 15 million litres of diesel fuel annually (Jones, 2010).

The benefits of integrating wind and hydro are multi-faceted, according to a private sector respondent, "[Wind and hydro] are the best partners, they complement each other perfectly. When the wind blows, you can save water behind the dam. We can then sell the hydro when the price is the best". A utility representative further explained that "when the wind is up, you can pull your hydro down. When the wind is down, you ramp your hydro up. As long as you can manage that level of variation and manage your reservoir without spilling – it's a natural complement".

Participants also believed that the seasonality of the province's wind resource was beneficial for the existing energy system. A private sector respondent stated: "[Wind patterns] follow our consumption as well. It is windier during the winter, where in Canada we consume more of our electricity".

(3) A number of participants supported the development of wind energy on the basis that some export markets prefer wind projects over large-scale hydroelectricity, due to environmental considerations. For example, a government representative stated, "We have struggled with the American governments; or the state governments' view on hydro power". The participant acknowledged that wind energy was seen as a preferred energy source, "In the United States, wind energy is perceived to be cleaner than hydro".

Participants expressed concern over some of the environmental impacts of large-scale hydroelectricity production, including carbon dioxide emissions during construction, methyl mercury contamination, and habitat destruction. Participants believed that relying on wind energy as opposed to hydroelectricity would help mitigate some of these impacts.

4.3.3: Societal Benefits of Wind Energy Development in NL

The following section will describe the social benefits themes identified during the analysis of data. The primary social themes developed were: (1) high level of social acceptance, (3) increased diversity, reliability of system, and (4) increased awareness of climate change.

(1) Participants believed that the province is uniquely situated for wind projects, due to high levels of social acceptance, which may be attributed to the availability of Crown land for development. As a utility representative stated, "We have a very low population density, and lots of Crown land available for development. The few people, who are around, would like to see economic development".

An academic participant contrasted NL with other jurisdictions: "In Newfoundland, there is lots of land, and you can easily find a place where there are no households around to build [wind turbines]. In Alberta, Ontario, or in Europe, this is a major issue. These are highly populated areas, and people do not allow you to install wind turbines [near their homes]".

(2) Participants promoted wind energy as a distributed source of energy that improves the reliability and diversity of the existing electrical system. As stated by an academic participant, "[Wind energy] is a distributed source of energy; distributed sources are always preferred over concentrated". When a jurisdiction relies heavily on a single source of power generation (i.e. the Holyrood Thermal Generating Station, or the Muskrat Falls Generating Station), they may be vulnerable to power outages or interruptions in production. As an academic participant stated, "If [Muskrat Falls] shuts downs, then there is no power. But if we have distributed generation very close to the load… it is highly unlikely that all of that will disappear".

(3) Participants promoted the development of wind energy in the province as a way to facilitate increased awareness about climate change, and to improve overall energy literacy. As an ENGO representative stated: "Once people get hooked into renewable energy, the increase in awareness of global warming goes way up. People then want to prevent or reduce global warming… people will reduce other habits associated with global warming like driving cars and oil consumption".

Chapter Five: Provincial 'Energy Transition' Framework and Discussion

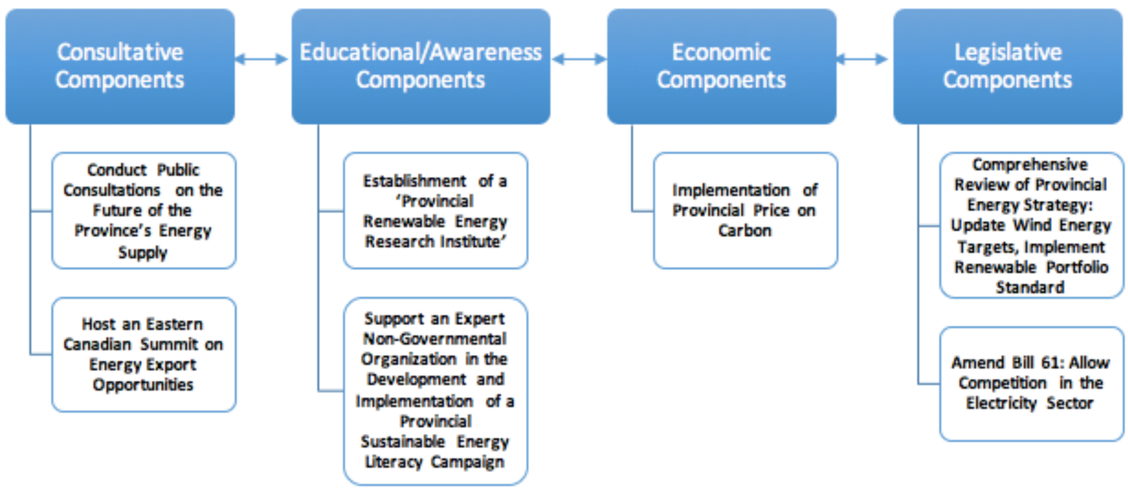
5.1: Overview of Discussion

The first objective of the chapter is the development of an 'Energy Transition Framework' for Newfoundland and Labrador consisting of policy recommendations; the framework is designed to decrease reliance on fossil fuels for electricity generation in the province and to encourage the development of renewable sources of energy (the focus of this thesis was wind power, but recommendations may also be beneficial for other sources of renewable energy). Each policy recommendation within the framework is derived from significant research findings, as established in Chapter Four. The second objective of this chapter is to discuss the implications of each policy recommendation and to determine how each theme/barrier relates to the existing literature; themes/barriers not covered in the 'Energy Transition Framework' will be discussed in section 5.3. The third objective of the chapter is to discuss how the findings contribute to Harris' (2006) 'Great Transition Theory' and the broader literature on energy transitions. The final objective of the chapter is to acknowledge and explain limitations of the study.

5.2: An Energy Transition Framework: Policy Recommendations for Newfoundland and Labrador

The following section establishes an 'Energy Transition Framework' for Newfoundland and Labrador; the framework consists of consultative, educational/awareness, economic, and legislative components **(Figure 5.1)**. Each policy recommendation within the framework is derived from specific themes or barriers to wind energy development, as established in Chapter Four. The policy recommendations are intended to encourage energy transition in NL – focusing on the development of wind power and other sources of renewable energy. Each recommendation includes a discussion section outlining the implications of the recommendation based on the existing literature.

Figure 5.1: 'Energy Transition Framework' for Newfoundland and Labrador



Policy Recommendation #1: Conduct Comprehensive Review of Provincial Energy Strategy: Update Wind Energy Development Targets, Implement Renewable Portfolio Standard, add other Educational and Economic Policy Instruments Outlined in this Framework

The principal policy recommendation derived from this study is for the provincial government to conduct a comprehensive review of the existing energy strategy. This review should implement new wind energy development targets for both utility-scale and small-scale wind or other renewable energy projects based on existing science; the province should establish a target of 300MW of utility-scale wind generation by 2035 - as determined feasible by Hatch (2012), and significantly increase the five megawatt cap under the existing net metering policy – as suggested is feasible by Fisher, Iqbal, and Fisher (2009), and other studies such as *Preliminary Assessment of Alternative Energy Potential in Coastal Labrador* (NL Hydro, 2009a). As part of this review, the province should adopt a 'Renewable Portfolio Standard' to support the wind energy targets (Wiser, Namovicz, Gielecki, & Smith, 2007). A new provincial energy strategy should also consider adopting the remaining consultative (i.e. hold provincial energy consultations, host an energy export summit), educational/awareness (i.e.: establishment of a provincial renewable energy research institute, support a sustainable energy literacy campaign, development of sustainable development curriculum for schools, etc.), financial (i.e. carbon price) and legislative (i.e. adopt a renewable portfolio standard, amend *Bill 61*) policy components outlined in this energy transition framework.

Relevant research findings for this policy recommendation include:

- Lack of Government Policy, Targets, and Political Will
- Governmental Preoccupation with Muskrat Falls, Oil & Gas Development
- Governmental Preference for Continuation of Status Quo

Discussion

A number of researchers have found that a lack of political will and policy support represents a barrier to wind energy development; for example, Wizelius (2007) concluded that for jurisdictions that have been successful in developing wind energy – such as Denmark, Germany, and Spain – their respective governments have sent clear political and policy signals encouraging the rapid development of wind energy. To contrast, the majority of participants in the current study believed that there is a lack of political will and policy support to facilitate wind energy development in the province. For example, NLs provincial energy strategy (2007), maintains that "the amount of wind generation that can be integrated into the current Island system is limited to approximately 80 MW" (p.27). However, more recent research suggests that 300MW of utility-scale wind energy will be feasible in the province by 2035 (Hatch, 2012). Therefore, the province's existing wind development targets are inaccurate and need to be updated. Furthermore, although the province has recently developed a 'net metering' policy, many participants believed that this will be an ineffective policy as it only allows for the development of five megawatts of small-scale energy sources. Fisher, Iqbal, & Fisher (2009) conclude that with updated transmission and system control, the island portion of the province could integrate as much as 440MW of small-scale wind energy into the power system.

Several researchers have concluded that a preference to 'continue the [energy] status quo' represents a barrier to renewable energy development (Michelsen & Madlener, 2013;

NRDC, 2009; Verbuggen et al., 2010). For example, Michelsen and Madlener (2013) determined that a key barrier to switching from fossil fuel heating systems (i.e. oil or gas boilers) to renewable residential heating systems, was homeowners' fear of major changes to their current status quo. At a broader scale, the NRDC (2009) concluded that 'legacy infrastructure' such as transmission grids designed for existing fossil-fuel generation plants, encourage the continued investment in carbon intensive energy – making it easier to continue with the status quo, as opposed to switching to renewables. Similarly, the current study found that there is an apparent preference for existing energy sources in the province; many participants believed that due to a history of hydroelectric development in the province, as well as diesel generators in remote communities, it is unnecessary to develop wind energy. Furthermore, the provincial government is preoccupied with oil and gas development, as well as an existing large-scale hydroelectric development (Muskrat Falls), and that until this project is complete, utilities and government actors may not consider the development of other renewables.

A policy instrument which has been promoted as an effective way to overcome these barriers is that of 'Renewable Portfolio Standards'. RPSs are essentially policies that mandate utilities to generate a certain amount of electricity (typically a percentage of overall generation) from renewable energy sources (Schelly, 2014). RPSs establish numeric targets for renewable energy supply, and they are typically backed by some form of financial penalty if the requirements are not achieved (Wiser, Namovicz, Gielecki, & Smith, 2007). According to the researchers, RPS have been successful in encouraging the development of renewable energy sources; they estimate that approximately half of the new renewable capacity additions in the United States from the late 1990’s to 2006 occurred in states with RPS policies, totaling roughly 5,500MW. Over 90% of these installations have come from wind power. The relative success of the use of RPSs in other jurisdictions suggests that implementing a RPS in NL for wind energy may provide the incentive needed to discontinue the status quo for energy production.

Policy Recommendation #2: Conduct Public Consultations on the Future of the Province’s Energy Supply

The provincial government should conduct wide-spread and in-depth public and expert consultations on the future of the province’s energy supply for both on-grid and off-grid communities. The proposed ‘Provincial Energy Consultations’ should also include the development of a framework for securing community acceptance for future renewable energy projects by establishing requirements for siting.

Relevant research findings for this policy recommendation include:

- Inadequate Public Consultation Regarding Energy Policy Decisions
- NIMBY Phenomenon
- Noise Impacts
- Avian Mortality
- Aesthetic Impacts

Discussion

A lack of consultation by the regional governments of local communities and the general public has previously been established as a barrier to the development of renewable energy (Nasirov, Silva & Ahostini, 2015; IRENA, 2012). According to UNEP (2005), at the policy development level, meaningful stakeholder participation in decision making and monitoring processes is the most reliable way to maximize benefits and prevent negative impacts from an [energy] policy. UNEP (2005) states

> "a multi-stakeholder approach ensures that different concerns, particularly of those most impacted by policy decisions, are heard and taken into account, and that the balance between economic growth, environmental issues and social concerns and different interests by different groups is established [and] constantly maintained through dialogue and debate" (p.2).

Effective stakeholder engagement ensures that energy policies and projects support human development and empower local communities. Furthermore, stakeholder engagement can ensure broad public support for energy decisions at the project and policy levels (UNEP, 2005).

A central theme that developed in this study was that inadequate public consultation has occurred in the province regarding energy policy decisions. Stakeholders from all areas –

including government, academia, the private sector, and community groups – were generally in agreement that inadequate or limited consultation has occurred with the general public regarding energy-related decisions. Furthermore, some participants believed that wind energy was not given serious consideration, as an alternative to the Muskrat Falls project. Because little consultation has occurred – it is possible that the development of renewable sources of energy, and their resulting economic and environmental benefits, have been neglected in the province in favour of government-preferred alternatives.

As previously discussed in the literature review, the NIMBYism phenomenon, noise effects from wind turbines, wildlife impacts, and aesthetic impacts are often cited as reasons why communities oppose the development of wind energy projects (Wizelius, 2007; Baster, Morzaria & Hirsch, 2013; Logan & Kaplan, 2009). Despite the existing literature, these societal issues were not found to be barriers affecting the rate of wind energy development in NL. Social acceptance of wind energy in the province is perceived to be very high; participants generally believed that this can be attributed to NL's vast availability of Crown land, meaning that potential wind energy developments would not encroach on people's homes. Some participants believed that social acceptance may be high for the time being, but as more wind development occurs, community opposition may intensify. Many researchers argue that the social (noise, aesthetics) and environmental (bird and bat mortality, habitat fragmentation) impacts of wind energy can be managed through proper site selection, as well a participatory approach in developing projects (Ledec, Rapp & Aiello, 2012; Erpp, 1997).

Policy Recommendation #3: Host an Eastern Canadian Summit on Energy Export Opportunities

In collaboration, and with the support of the federal government, the provincial government should take a leadership role is hosting an 'Eastern Canadian Summit on Energy Export Opportunities'. The summit would represent an important opportunity to gauge private sector interest in developing renewable energy and transmission capacity, collaborate with neighboring jurisdictions to secure export capacity (including the Maritime Provinces, Quebec), engage potential energy consumers (the Northeast United States, Ontario, etc.), and to develop a strategy for the future of energy exports.

Relevant research findings for this policy recommendation include:

Insufficient Provincial Demand - Limited Access to Export Markets

Discussion

Several researchers have concluded that often times, areas with the strongest renewable resource potential exist in sparsely populated regions, with little access to transmission lines; therefore, a lack of local demand often represents a barrier to renewable energy development (Mizra, Ahmad, Harjan & Majeed, 2009). Similarly, in NL there is a lack of domestic demand for utility-scale wind power; for example, in 2012, peak demand on the island's interconnected system was 1,581MW, while the total generating capacity was much greater at 1,958MW (DNR, 2012q). Peak demand is expected to increase to 1,924MW by 2030, but with the additional generating capacity from Muskrat Falls (824MW) coming online in 2018, there is limited domestic demand for additional wind development.

Because there is limited domestic demand for electricity in the province, any additional generating capacity that is built must be intended for export. NL faces a unique challenge with regards to electricity exports; the province is not connected to the broader North American electricity grid, with the exception of the Churchill Falls Generating Station in Labrador. Building transmission capacity is costly and is often cited as a barrier to renewable energy development; Mills, Wiser & Porter (2009) found that the median cost for building transmission capacity for wind power was $300/kW, this works out to approximately 15% of the cost of building a wind project. For some scenarios in their sample, transmission costs were as high as $1,500/kW, or roughly 75% of the cost of building a wind project. As NL is generally isolated from the North American grid, costs of transmission are much higher; for example, the Maritime Link which is being built as part of the Muskrat Falls Project, will have 500MW of transmission capacity from the island of Newfoundland to Nova Scotia, and will cost $1.56 billion (Emera, 2013). Based on the same numbers used by Mills, Wiser, & Porter, the Maritime Link will cost approximately $3,120/kW, or roughly 156% of the cost of building a wind project.

Despite the high costs of building transmission, participants believed that due to the high quality of the province's wind resources, wind projects built for the purpose of export can still be cost competitive. For example, while most commercial wind farms generally operate at a capacity factor of 25-30% (W3 Wind Energy Group, 2011), participants believed that new wind projects in the province with modern technology would likely reach or exceed 50% capacity factors, this means that much more energy will be produced per unit of investment compared to other jurisdictions. Outside of the province, there is high demand for renewable energy resources; a study commissioned by the Canadian Wind Energy Association found that export potential for wind energy from the Maritime Provinces is about 1,000MW, and is expected to grow to an estimated 2,5000MW by 2020 (Power Advisory LLC, 2009). Electricity demand for the region as a whole – including both the Maritime Provinces and the Northeastern United States – is expected to grow at a rate of 1.3% per year from 2010-2025, with a total increase of 25%.

Policy Recommendation #4: Establish a 'Provincial Renewable Energy Research Institute' (Assist in the Expansion of Sustainable Development Curriculum in Provinces Schools)

The provincial government should establish a 'Provincial Renewable Energy Research Institute' (PRERI) which conducts technical and social science research, provides advice to the provincial government, and conducts broader knowledge mobilization efforts on the development of renewable energy resources, with a specific focus on wind energy. PRERI should also be responsible for developing [education for sustainable development] curriculum for the province's schools, for training professionals, and building expert capacity in the provincial renewable energy sector.

It is recommended that PRERI includes representatives from relevant government departments, agencies, and other institutions including Nalcor, the Research and Development Corporation, the Office of Climate Change and Energy Efficiency, the Department of Natural Resources, the Department of Environment and Conservation, Memorial University, the College of the North Atlantic, as well as other interested community groups and private businesses. PRERI should actively engage in research on renewable energy, effectively share and communicate existing knowledge, and contribute to the development and implementation of energy policy in the province.

Relevant research findings for this policy recommendation include:

- Siloed Knowledge and Absence of Social Science Research
- Lack of Expert Capacity, Trained Professionals, Educational Programs

Discussion

In this study, as well as others (Scobie, 2016; Mitchell, 2005), siloed knowledge has emerged as a barrier to effective environmental action. Mitchell (2005) defines the 'silo effect' as "the separation of responsibilities among resource-management agencies as well as their inability or unwillingness to consider their mandate relative to those of other organizations" (p. 1340). Scobie (2016) concluded that the silo effect contributes to an unwillingness to share information between actors, and as a result decision-makers often lack credible data when formulating policy. In the current study, there were significant differences in the level of awareness among participants regarding previous wind energy research conducted in the province. Most concerning, research produced by the province's Crown Energy Corporation was often unknown to other governmental entities. Furthermore, research produced by some academics, was entirely unknown to academic researchers working in similar areas. While some utility and academic representatives believed that there was a high level of technical research taking place in the province – other academics, ENGO representatives, and private sector actors were unaware of any previous wind energy research. This suggests that the existing research has occurred in research siloes; that is, it has not been shared, or has been poorly communicated, with organizations with similar mandates.

As expected from this study's literature review, a lack of expert capacity, trained professionals, and educational programs in the province emerged as a barrier to renewable energy development. As stated by the ILO report (2011), "The shortage of green-collar professionals with cutting-edge skills in energy efficiency, green engineering, and green construction has already been identified in a number of countries as a major obstacle in implementing national strategies to cut greenhouse gas emissions" (p.v). Furthermore, Agenda 21, approved by the United Nations, called on all nations to develop and implement national strategies for ecologically sustainable development and concluded that scientific and technological education in the past have been too narrowly-focused (UNCED, 1992).

Participants in this study generally agreed that there is a lack of expert capacity and trained professionals in the renewable energy industry in NL. For example, Memorial University offers only an introduction to renewable energy systems course in its engineering program; the College of the North Atlantic does not offer any specialization in renewable energy, and there are limited opportunities for studying renewable energy at the graduate level. Furthermore, participants believed that grade school students do not receive enough exposure to renewable energy throughout their education. The lack of properly educated and trained professionals in the sector represents a barrier to renewable energy development in NL.

Policy Recommendation #5: Support an Expert Non-Governmental Organization in the Development and Implementation of a Provincial Sustainable Energy Literacy Campaign

The provincial government should finance and support an expert non-governmental organization in the development and implementation of a province-wide 'Sustainable Energy Literacy Campaign'. The primary objective of the campaign should be the ongoing education and awareness of the general public regarding energy use, energy sources, and energy's impact on the environment.

Relevant research findings for this policy recommendation include:

- Energy Literacy: Inadequate Knowledge and Understanding About Wind Energy
- Resource Potential vs. Technical Limitations

Discussion

According to DeWaters and Powers (2011) energy literacy includes broad content knowledge as well as affective and behavioral characteristics. As stated by Moore, Turcotte, Winter and Walp (2012) "an informed or literate public is critical for the long-term conservation, management, pricing and use of increasingly scarce energy resources" (para. 1). Sustainable energy literacy empowers the general public to make appropriate energy-related choices, and to support policy changes which affect the way we harness and consume energy (DeWaters & Powers, 2011). A vast majority of participants in the current study believed that there is inadequate knowledge and a high level of misunderstanding about energy sources in the province. Similar to the findings of this study, a number of researchers have demonstrated that energy-related knowledge in other North American jurisdictions is critically low (Bittle, Rochkind, & Ott, 2009; Curry, Ansolabehere, & Herzog, 2007). For example, the National Environmental Education and Training Foundation (2002) found that only 12% of Americans could pass a basic energy quiz.

In the current study, many participants were aware of the significant potential for wind energy development in the province; specific reference was made to the Canadian Wind Energy Atlas, which demonstrates that NL has amongst the strongest potential for wind energy development of any jurisdiction in North America (Government of Newfoundland and Labrador, 2007). However, only a small number of participants were aware of the technical limitations which affect how much renewable energy can be integrated into the existing grid. An independent energy literacy campaign could help inform the general public, as well as various energy stakeholders, of both the potential and limitations of wind energy development in the province.

It is noted that a number of energy education and awareness campaigns are currently underway in the province. For example, a subsidiary of the Crown Energy Corporation, Newfoundland and Labrador Hydro (Hydro), has developed' *Power Your Knowledge*, which "is designed to educate youth on the importance of electricity, and how electricity is generated and delivered to homes, businesses and institutions such as hospitals and schools" (NL Hydro, 2013, para. 1). The provincial government has launched their *'Turn Back the Tide'* initiative, through the Office of Climate Change and Energy Efficiency (OCCEE), which is a campaign designed to raise public awareness about climate change and energy efficiency (OCCEE, 2015). Newfoundland Power (a private-sector actor), in partnership with NL Hydro, are responsible for *Take Charge NL,* which is an energy efficiency awareness and rebate program (Newfoundland Power, n.d.). While these efforts are commendable, existing literature suggests that energy corporations, as well as the federal, provincial, and municipal levels of government, are not perceived as trustworthy sources of energy-related information by the general public (Moore et al, 2012). The authors state "the starting point for developing a comprehensive energy policy is to enlist the support of trusted spokespeople to convey the importance of the issue and explain the policy ramifications" (p.25). According to their study, academics and economic experts are perceived as the most trustworthy and credible sources of information. Therefore, the recommendation encourages the provincial government to fund either an existing non-governmental group of academic and economic experts in the development of a sustainable energy literacy campaign (such as a group within Memorial University, or the College of the North Atlantic), or to form a new organization.

Policy Recommendation #6: Implementation of a Provincial 'Price on Carbon'

As pledged with the signing of the *'Vancouver Declaration on clean growth and climate change',* the provincial government should collaborate with the other provinces and federal government to develop a 'carbon pricing' mechanism (Canada Intergovernmental Conference Secretariat, 2016). The provincial government should develop and implement a 'price on carbon' policy. The most commonly used methods for pricing carbon include a 'carbon tax' or a 'cap-and-trade' approach; NL's government should investigate and implement the most appropriate system in a provincial context.

Relevant research findings for this policy recommendation include:

- Cost Competitiveness of Wind Energy

- Fossil Fuel Subsidies and Externalities

Discussion

Similar to the findings of others (IEA, 2015), participants of the current study generally believed that wind energy is cost competitive with other forms of [newly built] energy production. Due to the high quality of the province's wind resources, wind energy is generally cheaper than fossil fuel production (both at the Holyrood Thermal Generating Station and at small-scale diesel generating plants) in the province, and is cost-competitive with other renewable technologies. Conversely, it was found that wind energy is not competitive with the province's existing hydroelectric facilities and is more expensive than natural gas generation on the U.S. spot market.

As discussed in the literature review, the negative economic externalities (including environmental damage and public health degradation) of fossil fuel power production (i.e. natural gas generation on the U.S. spot market) are considered a key market barrier to the penetration of renewable energy sources (Owen, 2006; Machol & Rizk, 2013). While all energy sources have externalities, renewable energy technologies' environmental and public health impacts are generally much less than fossil fuels' (European Commission, n.d.). Because renewable generation sources have lower emissions, increasing the cost of emissions (carbon dioxide, sulphur dioxide, nitrous oxide, etc.) would make renewable sources more cost competitive (Stiles, 2009).

Carbon pricing has emerged as a policy approach to mitigate increases in greenhouse gas emissions, and to make renewable energy more cost competitive with alternatives (Wilkinson, 2015). The two main policy approaches implemented by governments have included cap-and-trade systems, as well as carbon taxes; there is significant debate among scholars over which approach is more effective in reducing emissions (Goulder & Schein, 2015). A carbon tax directly establishes a price on carbon (CO2 emissions), whereas a cap-and-trade system sets a total quantity of emissions “allowances” each year. Allowances are sold to the highest bidder, and then can be traded on secondary markets, which effectively creates a carbon price (Kauffman, 2016). While it is beyond the scope of the current thesis to determine a preferable approach to pricing carbon, the existing literature suggests that both carbon taxes and cap-and-trade systems have been successful instruments for reducing greenhouse gases and increasing the competitiveness of renewables (Owen, 2006). Slavin (2011) argues that both policy approaches are similar and effective for achieving the goal of internalizing externalities and reducing carbon emissions, and that “the key questions that should be used to decide between these two policy approaches are: which is more politically feasible; and which is more likely to be well designed” (p. 101). As stated by Flavin et al (2014) “implementing a carbon tax could provide price signals to balance the impact caused by fossil fuel use, not only levelling the playing field for renewable energy sources in all countries, but making renewables more cost effective than fossil-fuel based generation” (p.48).

Policy Recommendation #7: Amend Bill 61: Allow Competition in the Electricity Sector

The seventh policy recommendation is for the provincial government to consider amendments to *Bill 61;* any such amendments should allow for [some] level of private-sector competition in the generation [and potentially long-distance transmission to the North American market] of electricity in the province. The amendment should also consider the need of stringent ex-ante, sector-specific regulation for competition. As the findings of this study demonstrate, wind energy is cost competitive with thermal generation, diesel-plants in remote communities, and newly built sources of renewable energy in the province. As such, the private-sector may be interested in competing to deliver electricity in the province's off-grid areas, export electricity via spare capacity on the Maritime Link, and to build future export capacity.

Relevant research findings for this policy recommendation include:

- Legislative Barriers: Bill 61
- Existing Monopoly in Electricity Market

Discussion

As established by previous researchers, legislative barriers in various countries often represent a barrier to renewable energy development (Beck & Martinot, 2004; Oikonomou et al; 2009). Beck and Martinot (2004) explain that in many jurisdictions, power utilities still control a monopoly on electricity production and distribution. Under these restrictions, independent power producers are unable to invest in renewable energy facilities and sell power to the grid, or to third-party users. In some cases, 'power-purchase agreements' may be negotiated on an individual basis, which causes difficulty for project developers who have to plan and finance projects based on unknown and inconsistent rules.

This barrier is particularly evident in NL, due to existing legislation which gives the Crown Energy Corporation (NL Hydro), and an existing private entity (Newfoundland Power), a monopoly over electricity production and distribution in the province. As stated by NEIA (2014) "*Bill 61…* effectively bans business development of renewable energy by entities other than Newfoundland Power or NL Hydro" (p.2). *Bill 61* gives an exclusive right to supply, transmit, distribute, and sell electricity to residential and industrial consumers on the island portion of the province (47th General Assembly, First Session, 2012).

Similar to the findings of others (Painuly, 2001; Flavin et al., 2014), a lack of competition (primarily as a result of *Bill 61*) was found to be a barrier to renewable energy development in the province. Often times, increased competition leads to significant price reductions, technological innovation, and increased choice for consumers (Davies, Coles, Olczak, Pike & Wilson, 2004). According to Brennan (2008), local electricity distribution and long-distance electricity transmission retain scale economies and other natural monopoly characteristics that impede any substantial competition. However, electrical generation and marketing sectors lack the same scale economies as distribution and transmission – and may benefit from increased competition; the researcher argues that competition may allow for additional development of renewable energy and generally lower prices for electricity. Available research suggests that the removal of monopoly rights for existing electricity producers and distributors is not enough for energy market functioning; it must be accompanied by stringent ex-ante regulation, that is sector-specific regulation for competition (Cameron, 2005).

5.3: Discussion of Remaining Themes: Agreement and Technological Barriers

This section is intended to address and discuss themes/barriers to wind energy development in NL that were covered in the preceding 'Energy Transition Framework'.

5.3.1: Agreement Related Issues: Debate over Job Creation Benefits, Governmental Preference for Mega-Projects

Two agreement related themes that have arisen from data analysis that have not been discussed in the 'Energy Transition Framework' include disagreement over the potential for job creation and economic benefit, as well as widespread debate over approaches to development (mega-project mentality versus the benefits of small-scale projects).

Many participants in the study viewed wind energy development as a valuable tool for economic development; they believed that expanding the existing tax base, land-owner royalties/payments, and job creation would be the primary economic benefits. Other participants were less optimistic about the potential for any economic activity from wind energy development. Examples from other jurisdictions suggest that wind energy development does create significant revenue for municipalities; for example, in March of 2015, Nova Scotia had 350MW of installed wind energy capacity, which produced $2 million per year in municipal tax revenue, or approximately $5,700 per MW (Union of Nova Scotia Municipalities, 2015). As for land-owner payments, previous experience across Canada suggests that the yearly minimum rent payments to landowners range from $1,250 to $5,000 per turbine, and royalties from 1.75% to 3% of gross revenues from turbines operating on landowner's property (Gipe & Murphy, 2005).

According to Gagnon, Leclerc, and Landry (2009), the majority of job creation benefits occur during the construction phase of wind projects. According to their study, a 100MW wind farm will create 71 direct, indirect, and induced jobs over a 14-month construction period. The operational and maintenance phase of a wind project creates 9 direct jobs per 100MW, or a total of 17 direct, indirect, and induced jobs. However, job creation benefits of energy development need to be kept in perspective by comparing energy sources. For example, a meta-analysis conducted by Kammen, Kapadia, and Fripp (2004) concluded that "overall, the renewable energy industry generates more jobs per megawatt-hour than the fossil fuel based industries (mining, refining and utilities)" (p. 12). For example, their analysis found that the wind energy industry creates 5.7 person-years of employment per million dollars in investment (over 10 years) and the solar PV industry creates 5.65 person-years of employment under the same scenario. In contrast, every million dollars invested in the coal industry creates only 3.96 years of employment over a 10-year period.

Many participants in this study believed that a governmental preference for mega-projects, as opposed to small-scale energy projects, represents a barrier to wind energy development in the province. For example, Roberts (2016) examines a recent report by the Atlantic Provinces Economic Council (APEC) suggesting that major-project spending (capital investments greater than $25 million) is particularly dominate in NL compared to other regions. The report concludes that of the $13.3 billion that was projected to be spent on major projects in Atlantic Canada in 2015, more than $8 billion was spent in NL; this is greater than 60% of major project spending in Atlantic Canada, despite the fact that NL represents less than one quarter of the region's population. Similarly, a number of researchers have documented a governmental preference for large-scale energy projects as opposed to small-scale renewable energy developments (Liu, Masera & Esser, 2013, p.5; Shirley & Kammen, 2015). Previous research has found that over reliance on capital and energy intensive mega-projects is not compatible with climate change mitigation strategies (Winkler & Marquand, 2009).

5.3.2: Technological Related Issues: Intermittency, Energy Storage, Spilt Energy, and Icing

As generally expected from the literature review, a number of technological issues emerged in the current study as barriers to wind energy development. Interestingly, a number of technical misconceptions also emerged. Key technological barriers to wind energy in NL included intermittency and insufficiency of energy storage options, spilt energy at the province's existing hydroelectric facilities, and in some regions the potential for icing of turbines. Technological misconceptions that emerged in the study included the belief that wind speeds were too strong for existing turbines, as well as thoughts surrounding the maturity/reliability of wind power technology.

Similar to the findings of others (Musgrove, 2012; Logan & Kaplan, 2009), participants in this study acknowledged that due to the intermittency of wind energy, the technology is not suitable as a 'base-load' energy source. However, as Lynn (2012) concluded, "There are no insuperable technical problems, at least up to [wind] penetration levels of 20%" (p.194). Logan and Kaplan (2009) determined that wind integration costs do not become significant until wind energy accounts for 15-30% of the capacity in a given system – beyond these levels, energy storage technologies are required and "most energy storage options are expensive and still under development" (p.12). Participants differed as to what they perceived as a 'technological maximum' for wind energy in the province, but generally believed that 10-35% wind penetration levels are technically and economically feasible in any isolated energy system. The island portion of the province currently has 54MW of installed wind energy capacity, and a total generating capacity of 1,958MW, meaning wind penetration levels are currently less than 3%; this suggests that the province is technically capable of integrating a much higher level of wind energy into the current system, and that the effects of intermittency are not an insurmountable barrier.

A somewhat unique technological barrier that emerged to wind energy in the province was ‘spilt energy at the province’s existing hydroelectric facilities’. Previous analysis by NL Hydro (2004) suggested that beyond 80MW of wind integration in the province, the risk for spilling stored water at the province’s existing reservoirs would negate the technical and economic feasibility of wind energy. However, a more recent analysis by Hatch (2012) concluded that by 2035, approximately 300MW of additional wind generation would be feasible. The risk of water spillage is a serious technical limitation which affects the feasibility of wind power development on the island’s interconnected system; however, this barrier is only significant in certain scenarios, as research suggests that much more than the current 54MW can be developed (NL Hydro, 2004; Hatch, 2012); the ability to export would negate the risk of water spillage, and the risk of water spillage has no implications for the province’s remote communities that are not connected to the main electricity grid.

Participants believed that icing is a site-specific issue which affects wind energy development in the province – with regions to avoid including the Northeast Avalon and Bonavista Peninsula; previous research suggests that icing of wind turbines and blades causes measurement and control errors, power losses, mechanical and electrical failures, as well as safety hazards (Parent & Illinca, 2011).

5.3.3: Technological Misconceptions: Wind Speeds, State of Wind Technology

Some participants in the study believed that wind speeds were too strong in the province for the widespread deployment of wind energy. However, this appears to be a misconception as available figures suggest that the typical values for survival speeds for commercial wind turbines (beyond which they can become damaged) range from approximately 145km/h to 260km/h, while the most common survival speed is typically 215km/h (Molina & Alvarez, 2011). For comparison, the Department of Natural Resources (2011) suggested that much of the province has average wind speeds of between 25-35 km/h at 50 metres above the ground. For the windiest areas of the province, along the south and west coasts, very strong gusts of wind between 120-140km/h are common (Heritage Newfoundland & Labrador, 2016). The available data regarding survival speeds for commercial turbines suggest that the province's wind speeds are not a technical barrier to wind energy development.

A small number of participants in the study believed that wind energy is not a mature technology and is not yet a reliable form of energy production. However, available literature suggests that wind energy is considered technologically mature, as Rangi et al (1992) state:

"Wind turbine technology has reached a mature status in the past decade as a result of international commercial competition, mass production and continuing technical success in R&D. The earlier concerns that wind turbines were expensive and unreliable have been largely allayed" (p.v.).

5.4: Theoretical Implications: 'The Great Transition Theory'

The current study has theoretical foundations in Harris' (2006) 'The Great Transition Theory' concept. Harris has argued that as economies have developed; most societies have been forced to move from one fuel source to another to meet their needs – traditionally relying on wood and other biomass, to coal, to oil and natural gas, and more recently to nuclear power. 'The Great Transition Theory' concept argues that the 21st century will see an even greater transition in energy sources. This theory is grounded in the basic laws of thermodynamics; ultimately concluding that as "our current economic activities depend heavily on the use of limited stocks [fossil fuels]. Ultimately, we must adapt our economic system to use the flow of solar energy, or solar flux [renewable energy sources]" (p.281). The findings of this study have a number of implications for Harris' 'great transition theory' including (1) comprehensive policy solutions are required for energy transition, (2) political will is a necessary and critical factor for energy transition, and (3) the abundance of fossil fuels necessitates a requirement for [energy transition] transformative factors other than scarcity.

5.4.1: Complexity of Energy Transition: Need for Comprehensive Policy Solutions

The current thesis demonstrates that energy transition, as described by Harris, is a complex and difficult process often impeded by several individual and interrelated barriers. As the findings of the study demonstrate, there is no single barrier to the development of renewable energy sources. Energy transition is a multi-faceted challenge; in this study, in fact, 24 unique categories – including agreement, knowledge, technical, economic, social, and political issues - were developed in data analysis which represent barriers to energy transition in the province. Furthermore, barriers to energy transition or renewable energy development do not occur in isolation; that is, they are complex and interrelated. For example, while 'Existing Monopoly in Electricity Market' emerged as an economic barrier to renewable energy development in the province, this is related to political barriers such as 'Legislative Barriers: Bill 61'. Additionally, while 'Noise Impacts' and 'Avian Mortality' emerged as perceived societal barriers to wind energy development, these themes can be attributed to knowledge barriers such as 'Energy Literacy: Inadequate Knowledge and Understanding about Wind Energy'. Also, while economic barriers such as 'Cost Competitiveness of Wind Energy' and 'Fossil Fuel Subsidies and Externalities' emerged, each of these are the direct result/or are affected by political and policy decisions.

Because energy transition is such a multifaceted problem, comprehensive policy frameworks comprising of consultative, economic, educational, and legislative components are needed to decrease reliance on fossil fuels. In the current case, a minimum of seven key policy recommendations were developed to bring wind energy onto a level playing field with existing alternatives and to encourage energy transition in the province. While each policy recommendation may seem piecemeal when examined individually, the thesis in its entirety argues for the development of a full energy transition strategy by the provincial government, with support from the federal government for implementation of specific aspects (i.e.: energy export opportunities, carbon pricing, etc).

5.4.2: Political Will is a Necessary and Critical Factor for Energy Transition

This study suggests that political barriers are the most prevalent issues affecting renewable energy development in Newfoundland and Labrador; as previously reported in chapter four, a large majority of participants (71%) believed that political issues were affecting the rate of wind energy development in the province. While other barriers to renewable energy development outside of the political realm certainly exist, the findings of this study suggest that many barriers to renewable energy development are less important and energy transition could be advanced if the necessary political will existed.

For example, the findings of this study suggested that wind energy is technologically mature, has high social acceptance, and in many cases is economically competitive with alternatives; therefore, wind energy has many of the necessary characteristics to encourage at least some degree of energy transition in the province. Despite this, political realities such as a lack of government policy, targets, and political will, a governmental preference for the continuation of the status-quo, legislative barriers, etc., remain as central barriers to transitioning to renewable sources of energy. Therefore, this study suggests that political will should be considered a keystone barrier to energy transition; as even if agreement, knowledge, technological, economic, and social barriers are resolved or are insignificant, political issues often remain the final barrier to developing renewable energy sources.

Furthermore, political will is also necessary for overcoming the significant and legitimate challenges facing the energy transition. For example, this study suggested that economic issues such as cost competiveness with natural gas generation, fossil fuel externalities and subsidies, knowledge related issues such as inadequate energy literacy, siloed knowledge: absence of social science research, as well as lack of expert capacity, trained professionals, and educational programs are important barriers to energy transition in the province. Without the political will to address these challenges, and a broader vision concerning future development opportunities – through policy measures such as implementing a carbon price, eliminating fossil fuel subsidies, and investing in education and awareness – the potential for energy transition remains limited. This study suggests that political will should be an important component of any research on energy transitions.

5.4.3: Fossil Fuel Abundance and the Requirement for Additional Transformative Factors

A central tenet of Harris' (2006) 'great transition theory' is that as economies have developed, and their primary energy sources became increasingly scarce, these societies were essentially forced to transition from one fuel source to another (from wood to coal, from coal to oil and natural gas, from fossil fuels to nuclear, etc.). Harris argues that the 21st century will see another great energy transition, from fossil fuels to renewable sources of energy.

The findings of this study suggest that a central barrier to energy transition in the province is that the provincial government is preoccupied with ongoing and potential oil and gas development; suggesting, that as fossil fuel resources remain abundant in the province, scarcity is not yet a factor encouraging energy transition as predicted by Harris' theory. Recent research suggests that if fossil fuel consumption continues at 2006 rates, the global reserves of oil, coal and gas will last a further 40, 200 and 70 years respectively (Shafiee, 2009).

As reserves of fossil fuels remain abundant, and governments remained preoccupied with their development, the findings of the study suggest that an additional 'transformative' factor other than scarcity may be required to facilitate the energy transition in certain cases. Examples of factors which have motivated energy transition in other cases include climate change concerns, the pursuit of energy security, economic development strategies, and the general promotion of environmental sustainability (Bartuska, 2006). When studying energy transitions, it may be necessary to study the scarcity of fossil fuels sources, but also the presence and/or absence of these additional transformative factors. In the introduction of this study, economic diversification and the promotion of environmental sustainability within the electricity generation sector were promoted as justifiable rationale for energy transition in Newfoundland and Labrador at this time.

Chapter Six: Conclusion

6.1: Introduction

The study set out to explore the concept of 'Energy Transition' and has identified barriers to renewable energy development [with a specific focus on wind power] in Newfoundland and Labrador, potential benefits of pursuing wind energy development, and policy approaches which would facilitate decreased reliance on fossil fuels in the province. The general theoretical and empirical literature on this subject in the context of NL is inconclusive in the 'energy transition' discourse. The central research question of the study was:

1) Adhering to Trudgill's (1990) 'AKTESP' framework for analysis, what are the most significant barriers/disadvantages (agreement, knowledge, technological, economic, social, and/or political) of wind energy in Newfoundland and Labrador, and how do they interact to inhibit wind energy development in the province?

Secondary research questions included:

2) What are the primary benefits of wind energy development in a provincial context?

3) Based on the barriers identified in the study, which policy measures would encourage the development of a viable wind energy industry in the province?

The concluding chapter of this study will first re-examine the importance of the problem at hand; discussing why it is imperative for NL to decrease its reliance on fossil fuels and to develop renewable sources of energy. Secondly, the chapter will acknowledge limitations of the study. Thirdly, the chapter will synthesize the research findings, taking an integrated look at the existing barriers and potential benefits of wind energy development in the province. Fourthly, the chapter will reconsider the theoretical and policy implications of the study. Finally, the chapter will conclude with recommendations for future areas of research.

6.2: Significance of the Problem: Over-Reliance on Fossil Fuels in NL

Newfoundland and Labrador represents a critical case study in the 'energy transition' literature. Despite having an abundant availability of renewable energy resources, the province remains dependent on fossil fuels for a significant portion of its economic activity and government revenue, as well as for a substantial share of its electricity generation.

The NL economy is highly dependent on the production of fossil fuels; in 2010, oil and gas royalties supplied approximately 31% of government revenue (CAPP, 2010). For every dollar drop in the yearly average price of a barrel of oil, the provincial government loses an estimated $30 million dollars (Bailey, 2014). Dependence on a single sector for such a significant portion of revenue can be highly detrimental for social programs and spending; for example, sources suggests that NL's $1.8 billion deficit in 2015, was "caused almost entirely by a slumping oil economy" (Cochrane, 2015).

A single oil-fired power plant, the Holyrood Thermal Generating Station, supplies between 15-25% of the provinces energy needs, rising to 30% during periods of peak demand (Department of Natural Resources, 2012). The plant emits an annual average of 1.1 million tonnes of greenhouse gases and approximately 11,600 tonnes of sulfur dioxide (Department of Natural Resources, 2012a); this makes the province a global contributor to environmental challenges such as climate change and acid rain. Furthermore, there are approximately 25 remote communities in the province that are not connected to the main electricity grid; these communities rely exclusively on diesel-fueled generation, and in total, burn approximately 15 million litres of diesel fuel annually (Jones, 2010). The province also operates multiple gas turbine plants, totaling over 150MW (Fisher, Iqbal & Fisher, 2009); these plants primarily exist for voltage stability, but also operate during periods of peak demand and in emergency circumstances (NL Hydro, 2012). While the island portion of the province often gets more than 65% of its power from hydroelectricity (Fisher, Iqbal, & Fisher, 2009), the province remains dependent on fossil fuels for covering a significant portion of its energy needs.

The province has considerable potential for renewable energy development; the provincial energy strategy recognizes 18,000MW of previously developed and identified renewable energy resources in the province (Government of NL, 2007); based on these numbers, peak electricity demand on the island is less than 9% of the available renewable energy (DNR, 2012). The province has amongst the strongest wind energy potential of any jurisdiction in North America; Fisher, Iqbal, and Fisher (2009) estimate that theoretically, if the province were converted to a wind farm, it would produce 117x times the amount of electricity consumed on the island in 2006. Despite this significant potential, the province's 54MW of installed wind energy capacity ranks third last amongst Canada's province's and territories.

Developing wind power and other sources of renewable energy would help the province decrease its reliance on the production and consumption of fossil fuels. Existing literature suggests that the benefits of renewable energy development are vast, including environmental, economic, and societal considerations. For example, the provinces existing utility-scale wind farms reduce GHG emissions by approximately 140,000 tonnes annually by displacing oil-fired electricity (OCCEE, 2011). CWEA (2013) suggests that if wind energy were to satisfy 20% of Canada's electricity demand by 2025, this would represent $79 billion in new investment, 52,000 new jobs, and $165 million in annual revenue for municipalities. Renewable energy also has significant public health benefits; for example, Machol and Rizk (2013) conclude that the economic cost of air quality caused health impacts from fossil fuel electricity-generation in the U.S. is US $361.7-

886.5 billion per year, or approximately 2.5-6.0% of the national GDP. In contrast, renewables generate electricity with little to no associated air pollution emissions.

6.3: Limitations of the Study

The following section will acknowledge and explain limitations of the study including longitudinal effects, implications of self-reported data, access to expert participants, and a lack of prior research studies on the topic.

- *Longitudinal Effects:* A primary limitation of the research project was that data collection took place over a limited five-month timeframe (September 2015 – January 2016). Barriers to renewable energy development are constantly evolving (i.e.: technology develops, interconnections are built to the North American grid, political circumstances change, etc.). This time-constraint was a limitation of the study, as it only assessed the state of RE development at the time of data collection, and may not be representative of the state of RE development over a more significant time period. For example, a provincial election occurred in the province in November 2015, which was during the data-collection period, and a new administration was elected. The election of a new administration may affect the political and policy realities affecting renewable energy development in the province. However, due to the study's theoretical breadth, lessons learned from the study are relevant for renewable energy development in the province currently, and many themes will remain relevant over time.

- *Self-Reported Data:* While expert interviews are a well-established research method within the social sciences, the self-reported data gathered from respondents has inherent biases and can sometimes be difficult to verify the validity of the information. For example, a number of private-sector respondents classified the current state of wind energy development in the province as 'unfavourable', their responses could potentially be influenced by their business interests in the province. To address this bias, the researcher included balanced representation from academia, government, the private sector, and community groups, and only included expert-participants based on inclusion criteria as set out in the ethical approval process. Furthermore, many participants referred to specific studies completed by the provincial and federal governments, as well as internal studies completed by the Crown Energy Corporation and other organizations, which are not readily available to the public and could not be cited. To test the validity of this information, the researcher would often present facts and figures to other expert-participants to verify the existence of the study or the accuracy of the data based on their experience.

- *Access to Expert Participants:* As previously described in Chapter Three, access to potential expert participants emerged as a limitation of the study. For example, while 34 potential experts in total were invited to participate in the study, only 17 respondents ultimately participated in the interviews. While many participants from academia, the private sector, and community groups were interested in participating in the study, the researcher experienced some degree of difficulty recruiting participants from government and from various Crown Corporations in particular. By employing a 'snowball sampling' method, the researcher was eventually able to recruit government participants from two different Crown Corporations and two government departments with energy related mandates. However, the depth of the study could have been improved by securing additional government participants – particularly from the Crown Energy Corporation(s), and the Department of Natural Resources – with specific expertise on renewable energy development in the province. Furthermore, a number of potential experts from academia and the private sector in particular, had to be turned away from participating in the study due to time and financial constraints.

- *Lack of Prior Research Studies on the Topic:* As previously discussed in the knowledge gap section of this study (Section 2.8), while a considerable degree of technical and scientific research has been completed, there is lack of peer-reviewed social science and policy research on renewable energy development in NL. For this reason, the researcher had to rely primarily on governmental sources of information, as well as peer-reviewed evidence from other jurisdictions, when completing the literature review, designing the study, and writing the discussion.

As this was an exploratory study, this did not have significant impacts on the findings of the study; however, previous research would have been helpful for establishing a background, designing the methods, and eventual analysis of the data.

6.4: Synthesis of Research Findings: Barriers to Wind Energy Development in NL

The study used a primarily qualitative, case-study approach, to assess barriers to wind energy development in Newfoundland and Labrador. Expert elicitation was utilized as the primary form of data collection, in total 17 expert interviews were conducted with balanced representation from academia, ENGOs, government, and the private sector. Interviews were organized according to Trudgill's (1990) 'AKTESP' framework for analysis, allowing participants to discuss agreement, knowledge, technological, economic, social, and political implications of wind energy development in the province. Data, in the form of interview transcripts, was then analyzed with content analysis with the assistance of NVIVO software. Ultimately, 24 unique themes emerged in data analysis which represented 'barriers' to renewable energy development in NL.

A large majority of participants (65%) classified the current state of wind energy development in the province as 'unfavourable'. Participants were then asked whether or not categories of the 'AKTESP' framework represented a barrier to wind energy development in the province; citing political (71% of respondents), economic (65%), and knowledge (53%) related issues as the primary barriers, followed by agreement (42%), technology (29%), and social perception (18%) as secondary barriers. A brief summary of the research findings is provided below – with themes arranged in the order of what experts believed to be the most significant barriers to wind energy development in the province.

Political Barriers

Political and policy related issues were by far the most prevalent area of discussion among expert participants. A number of key themes emerged here such as institutional barriers, lack of government policy, governmental preoccupation with existing projects, inadequate public consultation, governmental preference for the status quo, and legislative barriers.

Much discussion was directed towards the province's Crown Energy Corporation, Nalcor Energy, and its subsidiary, NL Hydro. Many experts believed that due to the mandates of utilities, they are inherently conservative institutions; their role is to make sure the lights turn on, at the least possible cost, which contributes to fear of any major changes/implementation of new technologies. Expert participants debated whether or not the institution has helped to facilitate or constrain wind energy development in the province – it is the opinion of the researcher, that the answer is 'both'. The Crown Energy Corporation was instrumental in developing the province's two existing wind farms – and has dedicated significant resources to researching and implementing small-scale wind energy projects (i.e: Ramea). Conversely, there appears to be a preference, and much of the institution's capacity, is directed towards the development of hydroelectricity – to the detriment of wind power. Utility-representatives stated explicitly that in the absence of government policy, the corporation has held back on residential and commercial small-scale wind. Furthermore, the utility has not been an effective 'knowledge mobilizer', the technical wind energy research they have completed has not been properly communicated to government, academics, and the private-sector.

A key barrier to wind development in the province is lack of government policy, targets, and political will. The existing energy strategy maintains a maximum target of 80MW of wind development; however, more recent research suggests that 300 additional megawatts will be feasible by 2035. Furthermore, there are no targets for wind in remote communities, and there are no economic incentives for wind developers. Moreover, until recently, NL was the only Canadian province without some form of 'net metering' policy, incentivizing small-scale residential and commercial wind; the province is now preparing to implement a 'net-metering' policy, although in its current form (with a cap of 5MW), the opportunities for small-scale wind are limited.

Expert participants largely agreed that the provincial government is currently preoccupied with the Muskrat Falls project, and that until this mega-project is complete, other renewables may not be considered in any capacity. In addition, participants also believed that the provincial government and its various entities are too focused on offshore oil and gas development, and that not enough priority has been given to renewable technologies.

The general public of the province, as well as the experts in the field, have not been properly consulted with regards to energy decisions in NL. Academics, community-groups, and the private sector, were largely in agreement that their advice has not been sought on any major energy policy decisions; a number of government participants also acknowledged that they have not conducted public consultations. This general lack of consultation was also prevalent during the sanctioning of Muskrat Falls; many participants expressed concern that a realistic wind energy option was not given serious consideration as an alternative.

A central theme that emerged was 'preference for the continuation of the status quo'. Participants believed that due to the province's 'hydroelectric history', there was little appetite to consider new technologies. Furthermore, as remote communities already have a 'reliable' form of electricity generation (diesel generators), there was no need to implement wind energy.

A final political theme that emerged was that of 'Legislative Barriers'. Existing legislation in the province, Bill 61, gives the exclusive right to the Crown Energy Corporation, as well as one private sector entity, to supply, transmit, sell, and distribute wholesale electricity in the province. This is a clear barrier to renewable energy development, as no actor outside of the Crown Energy Corporation, is permitted to develop energy sources for sale on the grid in the province.

Economic Barriers

Economic issues were prevalent in the study; the primary themes which emerged were related to cost competitiveness, lack of demand/market access, lack of competition, as well as fossil fuel subsides and externalities. Due to the high quality of the province's wind resources, wind energy is generally cost competitive with other forms of electricity generation in the province. Utility-scale wind power is less expensive than the Holyrood Thermal Generating Station and other forms of renewable energy; small-scale wind energy is cost competitive with diesel generation in remote communities. However, wind energy is not currently cost competitive with the province's existing hydroelectric facilities, and is more expensive than natural gas generation on the U.S. spot market.

There is limited domestic demand for additional wind energy development in the province; for this reason, most future utility-scale wind farms will have to be built for the purpose of export. The Maritime Link offers some opportunity for additional wind development, but any additional transmission capacity to external markets may be prohibitively costly.

There is currently a lack of private sector competition for electricity generation in the province, although this is partially attributed to existing legislation, the fact of the matter remains that private sector renewable energy developers are currently not competing with existing generators to deliver electricity for the lowest cost – this is true for both the isolated island system, as well as in the province's remote communities.

Existing fossil fuel subsidies, as well as negative economic externalities, were identified as barriers to wind energy development in the province. While the literature review of this study demonstrated that fossil fuel subsides are magnitudes greater than those for renewable energy, there are very-specific subsidies in the province for diesel-electricity, oil and gas producers, etc., which create an un-even playing field for renewable electricity. Furthermore, the public health costs of fossil fuels resulting from emissions are currently un-priced and affect the competitiveness of renewables.

Knowledge Barriers

The principal knowledge related barriers that emerged in the study included 'energy literacy: inadequate knowledge and understanding about wind energy', 'siloed knowledge: absence of social science research', and 'lack of expert capacity, trained professionals, educational programs'.

There is not a high level of knowledge and understanding about energy sources, energy use, and environmental implications of electricity generation in the province. In particular, participants believed that there is a high level misinformation about wind energy in the province regarding the cost of the technology, the maturity/reliability of the technology, and societal impacts (i.e.: noise, environmental impacts). This level of misinformation may be attributed to a lack of exposure to the technology, as the vast majority of the population lives far from existing utility-scale wind farms.

'Siloed Knowledge' emerged as a critical barrier to wind energy development in the province. The findings of the study suggested that government entities (departments, offices, crown corporations, etc.) as well as community groups, academics, and the private sector, who all share similar mandates [i.e. related to energy development], have not effectively collaborated or shared information with one another to date. For example, there are government departments in the province who are unaware of research completed by the Crown Energy Corporation, there are academics in the renewable energy field who are unaware of research completed by other academics, and in some cases the private sector/ENGOs have been ignored or not properly engaged. Furthermore, while a growing body of technical research has been completed on wind energy in the province, there is little evidence of any social science research.

Potentially due to the fact that renewable energy development has been limited in the province (excluding large-scale hydroelectricity), there is a lack of expert capacity, trained professionals, and educational programs related to renewable energy development in the province. The provinces post-secondary institutions offer no specialization in renewable energy and there is limited opportunity for study at the graduate level. Furthermore, many participants suggested that more exposure to renewable energy needs to take place at the grade-school level to familiarize students with the technology/opportunities in the field.

Agreement Barriers

Multiple agreement related issues emerged in the study including 'disagreement over potential for job creation and economic benefit', 'approach to development: mega-project mentality vs. small-scale projects', and 'resource potential vs. technical limitations'.

Wind energy is often promoted as a valuable tool for economic development; cited benefits include local investment, municipal/rural revenue generation, and employment; there was considerable debate in the current study regarding how much employment wind energy creates. Wind turbine component manufacturing and the construction of wind farms are considerable job creators; however, employment is limited during the operational and maintenance phases of wind projects.

NL has traditionally relied on 'mega-projects' as a form of economic development – as a result, small-scale energy projects such as wind energy developments, may not have been given serious consideration in the past. There is a growing body of literature that suggests energy and capital intensive mega-projects are not compatible with climate change mitigation strategies (Winkler & Marquand, 2009). Conversely, researchers have suggested small-scale energy projects have significant potential in the province and could potentially replace thermal-generation (Fisher, Iqbal, & Fisher, 2009).

There is significant potential for wind energy development in the province; however, it is important to acknowledge the technical limitations of the current electricity system. By acknowledging and understanding the technical constraints (intermittency/energy storage implications, spilt energy, icing, etc.) facing wind energy development in the province, realistic strategies may be developed for the advancement of renewable energy sources.

Technological Barriers

A number of technical issues emerged in the study which are limiting the widespread deployment of wind energy development in the province. The main themes developed in this category were related to the intermittency of wind energy, the icing of turbines, spilt-energy at the province's existing hydroelectric facilities, and other technical concerns.

Because the wind does not always blow when energy is needed, it cannot be relied on for base-load power (without feasible energy storage options). However, wind energy (and other variable sources, such as solar, wave, etc.) can provide a significant portion of most electricity systems without any major system upgrades. Wind energy on the island portion of the province currently supplies less than 3% of peak electricity demand, which is well below what most experts estimated to be the 'industry standard' of 10-30% as being feasible. In the province's remote communities, wind energy could displace some level of diesel-fired electricity.

Icing is an issue which affects wind energy development in some regions of the province; for most regions, this can generally be overcome with proper siting and de-icing technology. Due to the province's harsh environment, some sites may be prone to icing of turbines which leads to power losses, mechanical and electrical failures, safety concerns, etc. According to the experts, areas to avoid included Bonavista Peninsula and the Northeast Avalon. There was some debate regarding the potential for icing in Labrador, although a utility representative presented data suggesting that this was not an issue.

Spilt-energy at the province's existing hydroelectric facilities represents a main limitation to wind energy development in the province. Multiple technical analyses have been completed by the Crown Energy Corporation suggesting that beyond a certain amount of wind penetration, the risk for spilling water over the dam at the province's existing hydro stations becomes too great. The most recent analysis suggests 300MW of additional utility-scale wind generation will be feasible by 2035 (Hatch, 2012). The Maritime Link, as well as any other potential transmission to the North American grid, will offer additional opportunity for wind energy; as excess electricity will be able to be exported and decrease the risk of water spillage.

Some technical misconceptions about wind energy also emerged in the study. For instance, a small number of participants believed that the province's wind speeds may be too strong for available commercial turbines, and that wind energy technology was still immature/unreliable. Data presented in the discussion chapter of this paper explained that wind energy is in fact a mature technology, and that standard commercial wind turbines are well capable of handling NL wind speeds.

Social Barriers

NL is uniquely situated for wind energy development, as not only is the quality of the wind resource high, but public acceptance of the technology appears to be significant. Because the province has so much Crown land available for development, potential wind projects are not likely to encroach on people's properties , avoiding much community opposition. Despite high social acceptance, some societal concerns did emerge in the study including that of the 'NIMBY' phenomenon, noise impacts, avian mortality, and aesthetic effects.

NIMBYism has not been prevalent in the province to date, and communities with and without wind energy have been highly supportive of wind projects. Despite this, some participants expressed concerns that future wind projects may face community opposition based on the noise from wind turbines, potential wildlife impacts, and impacts on the view shed.

Based on this study's literature review and consultation with the expert participants, it was found that these are not significant issues affecting wind energy development in the province – and that in the future, through proper siting of turbines, community engagement, and modern technology, these issues can be largely mitigated.

6.5: Theoretical Implications

The study had its theoretical foundations in Harris' (2006) 'great transition theory'. Harris essentially argues, that due to the basic laws of thermodynamics, modern society will eventually have to transition from 'limited stocks' (i.e.: coal, oil, natural gas), to 'solar flows' (i.e.: wind, solar, hydro, geothermal) for electricity-generation. This study aimed to take Harris' theory one step further, by investigating and identifying the complex barriers which are preventing energy transition, by completing an in-depth case study of wind energy development in Newfoundland and Labrador.

What the study essentially found is that 'energy transition' is a complex issue, with no single solution. Barriers to energy transition are multi-faceted, and existing roadblocks are both interrelated and individual. By applying the 'AKTESP' analysis framework, this study was able to identify 24 'themes' which are affecting the 'energy transition' in Newfoundland and Labrador. Challenges facing the energy transition were found to be related to agreement, knowledge, technological, economic, social, and political in nature. In order to encourage and achieve an 'energy transition' in any given jurisdiction, comprehensive policy frameworks, based on in-depth expert and public consultation, are required that include legislative, technological, educational, and economic components.

Furthermore, the study suggests that political will is a critical factor influencing energy transition in the province. The findings of the study suggested that wind energy is technologically mature, has high social acceptance, and in many cases is cost competitive with alternatives. Despite this, political barriers remain which inhibit wind energy development in the province. The findings suggest that political will should be given careful consideration in future studies of energy transitions.

The study also suggests that additional 'transformative' factors for energy transition may be required. Harris (2006) argued in his 'great transition theory' concept that scarcity of primary fuel sources often forces societies to transition to new sources of energy. This study suggests that the provincial government continues to be preoccupied with ongoing and potential oil and gas development, and that scarcity is not yet a critical factor encouraging energy transition in the province. For this reason, the study suggests that future studies of energy transitions consider additional motivational factors for energy transition such as the presence and/or absence of concern for climate change, economic development strategies, the pursuit of energy security, and general awareness of environmental sustainability.

6.6: The Energy Transition Framework for NL

Based on the findings of the study, and further informed by the literature review and broader policy research, a comprehensive 'Energy Transition Framework' consisting of policy recommendations was developed. The framework consisted of educational, legislative, economic, and consultative components; the framework is intended to assist policymakers decrease reliance on fossil-fuels in the province and encourage the development of renewable sources of energy. The seven policy recommendations are summarized below.

Conduct Comprehensive Review of Provincial Energy Strategy: Update Wind Energy Development Targets, Implement Renewable Portfolio Standard, add other Educational and Economic Policy Instruments Outlined in this Framework

The primary policy recommendation developed as a part of this study was for the provincial government to conduct a comprehensive review of the existing energy strategy. This review should develop and implement new utility-scale and small-scale wind energy targets (and other renewable energy sources) based on existing science, implement a renewable portfolio standard, and consider implement the remaining educational/economic policy instruments outlined in the study's proposed 'Energy Transition Framework'. Conducting a review of the provincial energy strategy, and developing and implementing new wind energy targets for both utility-scale wind, and small-scale energy sources, may send a clear policy signal that the provincial government is serious about developing renewable energy; furthermore, potentially binding targets through the use of a Renewable Portfolio Standard may arrest the governments preoccupation with Muskrat Falls, oil and gas development, and an existing preference to continue the status quo.

The existing provincial energy strategy maintains 80MW of wind energy is the province's technical maximum, more recent research suggests an additional 300MW of wind energy will be feasible by 2035 (Hatch, 2012). Furthermore, while the province's recently released 'net metering' policy sets a cap of 5MW of small-scale energy, available research suggests the province could integrate as much as 440MW small-scale energy sources (Fisher, Iqbal, & Fisher, 2009).

Conduct Public Consultations on the Future of the Province's Energy Supply

A general lack of public and expert consultation with regards to energy decisions emerged as a barrier to wind energy development in the province. Expert academics, community groups, and relevant private sector organizations have been inadequately consulted, and the general public has not been properly engaged. According to UNEP

(2005), at the policy development level, meaningful stakeholder participation in decision making and monitoring processes is the most reliable way to maximize benefits and prevent negative impacts from an [energy] policy. Conducting a comprehensive, province-wide, energy strategy consultation would help the provincial government determine which energy strategies would optimize benefits for the province – and have the least negative environmental and societal side-effects. While societal barriers such as the NIMBY phenomenon, noise impacts from turbines, wildlife impacts, and aesthetic impacts were discussed by participants in the study, participants generally believed that these are not currently significant barriers to wind energy development in the province. However, a province-wide energy consultation may help identify key societal concerns, and develop strategies to mitigate negative effects of renewable energy development.

Host an Eastern Canadian Summit on Energy Export Opportunities

The current study found that there is limited domestic demand for additional utility-scale wind generation in the province; for this reason, most additional generating capacity must be built for the purpose of export. NL faces a unique challenge here, as it is currently not connected to the broader North American gird, and building additional transmission capacity to export markets is costly. Despite this, experts believed that due to the high quality of the provinces wind resources, building transmission and exporting wind energy to the Maritimes and Northeast United States may still be cost-competitive. In collaboration with the federal government, Hosting an 'Eastern Canadian Summit on

Energy Export Opportunities' may allow the private-sector/potential developers to gain an understanding of spare capacity on the Maritime Link, to determine interest for building additional transmission, and to collaborate with neighbouring jurisdictions who are dependent on fossil fuels.

Establishment of a 'Provincial Renewable Energy Research Institute'

Siloed knowledge, as well as a lack of expert capacity, trained professionals, and educational programs, have emerged as key barriers to renewable energy development in NL. By establishing a provincial research institute, key players in the province's energy sector, including the government, academics, community groups, and the private sector, may be able to collaborate, share knowledge, and effectively contribute to the development of energy policy. The research institute could be well situated to strengthen expert capacity, decide which training programs are most critical for the province's needs, and to inform broader education and awareness efforts regarding energy and its implications for the environment.

Support an Expert Non-Governmental Organization in the Development and Implementation of a Provincial Sustainable Energy Literacy Campaign

Energy literacy, as well as ongoing tension between 'wind energy potential' and 'technical limitations of the existing system' emerged as barriers to wind energy development in the province. By supporting an expert non-governmental organization in the development and implementation of an energy literacy campaign, the general public of the province may gain the required knowledge to make environmentally benign decisions with regards to energy-use. While it is noted that various entities of government, and a private-sector utility, currently have energy literacy campaigns underway (including *Power Your Knowledge, Take Charge, and Turn Back the Tide*) – the existing literature suggests that energy companies, as well as government entities, are typically the least-trusted sources of energy related information (Moore et al, 2012). Moore et al (2012) conclude that the general public regards academic and economic experts as the most trustworthy and credible sources of energy-related information; for this reason, an expert non-governmental organization should be tasked with developing and implementing a sustainable energy literacy campaign.

Implementation of a Provincial 'Price on Carbon'

Much of the discussion in the study concentrated on the cost-competitiveness of wind energy, as well on existing fossil fuel subsidies and externalities. While it was generally found that wind energy is cost competitive with thermal-generation, diesel-fired electricity, and other newly built renewables in the province, wind energy cannot currently compete with existing hydroelectric facilities or natural gas generation on the U.S. spot market. Furthermore, because the negative externalities of fossil fuels (environmental degradation, public health costs, etc.) are not accounted for in their retail price, the true costs of fossil fuels are distorted and this affects the competitiveness of renewables (which typically have far less externalities). Implementing a provincial price on carbon (either a carbon-tax, or cap-and-trade system) would help make renewables more cost competitive with alternatives, and revenues could help pay the environmental and public health costs of consuming fossil fuels.

Amend Bill 61: Allow Competition in the Electricity Sector

A key barrier to wind energy development in the province is legislative in nature; *Bill 61*, gives the Crown Energy Corporation an exclusive right to supply, transmit, distribute, and sell wholesale electricity in the province. In NL, the private sector is essentially unable to participate in any aspect of renewable energy development. While it is acknowledged that the distribution and transmission of electricity often requires economies of scale (thus is conducive to natural monopolies), the electricity marketing and generating sectors typically lack these characteristics (Brennan, 2008). Thus, the available literature suggests that amending *Bill 61* and introducing some level of private sector competition accompanied by stringent ex-ante sector-specific regulation for competition in the energy market may contribute to electricity price reductions, technological innovation, and increased choices for consumers (Davies, Coles, Olczak, Pike & Wilson, 2004).

6.7: Recommendations for Future Research

A final task of the current thesis is to provide some insight on areas that are in need of additional study. Based on the knowledge gaps identified in the study, the following areas are recommended for future research.

Provincial Approach to Economic Development

A key agreement-related barrier which emerged in the current study was the ongoing debate of which development approach is more effective and compatible with sustainability: mega-projects, or small-scale energy projects. There is limited literature in the province on the positive/negative impacts of ongoing mega-projects, or the potential of small-scale energy projects. There is need for research on how mega-projects have served Newfoundland and Labrador, and if there is a more appropriate approach for community-based development.

Policy Comparison: Cap-and-Trade versus Carbon Tax

Cost competitiveness emerged as a barrier to wind energy development in this study; accordingly, a 'price on carbon' was recommended as a policy approach to help overcome this barrier. There is widespread debate in the existing literature on the most preferable approach to pricing carbon, with carbon taxes and cap-and-trade systems being the most common policies (Goulder & Schein, 2015). Research into which carbon pricing system is most appropriate in a provincial context is required.

Environmental Education: The Current State of Provincial Sustainable Development Curriculum

A main theme that developed in this study was 'A Lack of Expert Capacity, Trained Professionals, Educational Programs'. While most discussion from respondents concentrated on the fact the there is limited opportunity for specialized training in renewable energy development in the province, a small number of respondents also mentioned that sustainable development curriculum within the provinces school is not sufficient. It is important to investigate the current state of provincial sustainable development curriculum within the province – including how extensive renewable energy education is at the grade school level, if the curriculum outcomes are being achieved, and how education for sustainable development can be improved in the province.

Economic Analysis: Wind Energy Export Opportunities and Transmission Costs

With some of the strongest wind energy potential of any jurisdiction in North America, the theoretical potential for wind power development in NL is extensive. However, because domestic electricity demand is insufficient, and the province is not currently connected to the larger North American grid, the potential for utility-scale wind development in the province is limited. Thus, it is necessary to investigate the economic cost of building transmission capacity to the Maritimes and Northeast United States, and determining whether NL wind energy will be cost competitive in the future.

Siloed Knowledge: How Extensive is the Problem?

In the current study, siloed knowledge emerged as a key barrier to wind energy development in NL. It was found that existing knowledge and research surrounding renewable energy development have been poorly communicated and not shared with organizations with similar mandates. As energy only represents one small-sector of which the provincial government is responsible for, future research into 'research siloes' amongst other natural-resource sectors in the province may prove valuable in overcoming this barrier.

References Cited:

Ackermann, T., & Soder, L. (2002). An overview of wind energy-status 2002. *Renewable and sustainable energy reviews, 6*(1), 67-127.

Arnett, E. D., Schirmacher, M., Huso, M. M. P., & Hayes, J. P. (2009, April). Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. Retrieved from http://www.batsandwind.org/pdf/Curtailment_2008_Final_Report.pdf

Bailey, S. The Globe and Mail. (2014). Crude oil's fall raises budget concerns in Newfoundland and Labrador. Retrieved from http://www.theglobeandmail.com/news/national/crude-oils-fall-raises-budget-concerns-in-newfoundland-and-labrador/article21471065/

Baerwald, E. F., D'Amours, G. H., Klug, B. J., & Barclay, R. M. (2008). Barotrauma is a significant cause of bat fatalities at wind turbines. *Current biology*, *18*(16), R695-R696.

Bartuska, A. (2006). *Why biomass is important: The role of the USDA forest service in managing and using biomass for energy and other uses* (pp. 1-16). Research & Development, USDA Forest Service.

Batel, S., Devine-Wright, P., & Tangeland, T. (2013). Social acceptance of low carbon energy and associated infrastructures: A critical discussion. *Energy Policy*, *58*, 1-5.

Baxter, J., Morzaria, R., & Hirsch, R. (2013). A case-control study of support/opposition to wind turbines: Perceptions of health risk, economic benefits, and community conflict. *Energy Policy*, *61*, 931-943.

Beck, F., & Martinot, E. (2004). Renewable energy policies and barriers. In Cleveland, C. J. (Ed). Encyclopedia of Energy. San Diego, CA: Academic Press/Elsevier Science.

Bell, D., Gray, T., Haggett, C., & Swaffield, J. (2013). Re-visiting the 'social gap': public opinion and relations of power in the local politics of wind energy. *Environmental Politics*, *22*(1), 115-135.

Bittle, S., Rochkin, J., Ott, A. (2009). The energy learning curve: Coming from different starting points, the public sees similar solutions. Retrieved from http://www.publicagenda.org/files/energy_learning_curve.pdf

Blackler, T., & Iqbal, M. T. (2006). Pre-feasibility study of wind power generation in Holyrood, Newfoundland. *Renewable Energy*, *31*(4), 489-502.

Boykoff, M. T. (2011). *Who speaks for the climate?: Making sense of media reporting on climate change.* Cambridge, UK: Cambridge University Press.

Bradshaw, G. A., & Borchers, J. G. (2000). Uncertainty as information: narrowing the science-policy gap. *Conservation ecology*, *4*(1), 7.

Brennan, T. J. (2008). Generating the benefits of competition: Challenges and opportunities in opening electricity markets. Retrieved from http://search.proquest.com/openview/c06787ca1388673098af4f38a47c00ac/1?pq-origsite=gscholar

Burningham, K., Barnett, J., & Walker, G. (2015). An array of deficits: unpacking NIMBY discourses in wind energy developers' conceptualizations of their local opponents. *Society & Natural Resources*, *28*(3), 246-260.

Calhoun, C. (2002). Dictionary of the social sciences. Retrieved from http://www.oxfordreference.com/view/10.1093/acref/9780195123715.001.0001/acref-9780195123715-e-670?rskey=aj4TZf&result=670

Calvert, A. M., Bishop, C. A., Elliot, R. D., Krebs, E. A., Kydd, T. M., Machtans, C. S., & Robertson, G. J. (2013). A Synthesis of Human-related Avian Mortality in Canada. *Avian Conservation and Ecology*, *8*(2), 11.

Cameron, P. D. (2005). The internal market in energy: harnessing the new regulatory regime. *European law review*, (5), 631-649.

Canadian Association of Petroleum Producers. (2010). Publications. Retrieved from http://www.capp.ca/publications-and-statistics/publications#sort=%40fpublicationdate15386%20descending

Canadian Intergovernmental Conference Secretariat. (2016, March). Vancouver declaration on clean growth and climate change. Retrieved from http://www.scics.gc.ca/english/conferences.asp?a=viewdocument&id=2401

Canadian Wind Energy Association. (2013, January). Canadian Wind Farms. Retrieved from http://www.canwea.ca/farms/index_.php

Canadian Wind Energy Association. (2013, January). Wind by the numbers: Economic benefits of wind energy. Retrieved from http://canwea.ca/pdf/canwea-factsheet-economic-web-final.pdf

Canadian Wind Energy Association. (2015, December). Installed capacity. Retrieved from http://canwea.ca/wind-energy/installed-capacity/

Canadian Wind Energy Atlas [computer file]. Gatineau, QC: Environment Canada, 2003.

Carls, J., Haffar, W. R., Jones, L. E., & Morey, J. E. (2010). *Conflict Resolution of the Boruca Hydro-Energy Project: Renewable Energy Production in Costa Rica*. New York, NY: Bloomsbury Publishing USA.

Carter, N. (2001). *The politics of the environment: ideas, activism, policy.* Cambridge, UK: Cambridge University Press.

CBC News. (2016, February). Sask. Premier Brad Wall says federal carbon tax could take $1.3B out of provincial economy. Retrieved from http://www.cbc.ca/news/canada/saskatoon/brad-wall-billion-economy-carbon-tax-1.3469377

CBC News. (2016, August). Still risk of major outages even after Muskrat Falls, says report on N.L. power supply. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/continuted-outage-risk-after-muskrat-falls-1.3653603

Cochrane, D. CBC News. (2015, December 1). N.L. deficit balloons to $1.8 billion, as Liberals take rein. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/deficit-projection-1.3345756

Consultative Group on International Agricultural Research. (2014). *Info note: Climate change, food security, and small-scale producers.* Retrieved from https://cgspace.cgiar.org/rest/bitstreams/30971/retrieve

Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R.,… Skuce, S. (2013). Quantifying the consensus on anthropocentric global warming in the scientific literature. *Environmental Research Letters, 8*(2), 1-7.

Council of Canadian Academies. (2015). *Understanding the evidence - wind turbine noise: the expert panel on wind turbine noise and human health.* Ottawa, ON: Author.

Curry, T. E., Ansolabehere, S., & Herzog, H. (2007). A survey of public attitudes towards climate change and climate change mitigation technologies in the United States: Analyses of 2006 results. Retrieved from https://sequestration.mit.edu/pdf/LFEE_2007_01_WP.pdf

Czech, B., & Daly, H. E. (2004). The steady state economy-what it is, entails, and connotes. *Wildlife Society Bulletin*, *32*(2), 598-605.

Daly, H. E. (1997). Beyond growth: the economics of sustainable development. Beacon, Boston, Massachusetts, USA

Davies, S., Coles, H., Olczak, M., Pike, C., & Wilson, C. (2004). Benefits from competition: Some illustrative UK cases. Retrieved from http://eprints.aston.ac.uk/18473/1/Benefits_from_competition.pdf

DeCarolis, J. F., & Keith, D. W. (2006). The economics of large-scale wind power in a carbon constrained world. *Energy Policy*, *34*(4), 395-410.

Department of Mines and Energy (2003, July). Government directs PUB to maintain status quo on rural rate subsidy. Retrieved from http://www.releases.gov.nl.ca/releases/2003/mines&en/0709n09.htm

Department of Natural Resources. (2005). Newfoundland and Labrador energy plan discussion paper. Retrieved from http://www.nr.gov.nl.ca/nr/energy/plan/pdf/section1.pdf

Department of Natural Resources (2006, December). NL announces award of second wind energy contract. Retrieved from http://www.releases.gov.nl.ca/releases/2006/nr/1214n06.htm

Department of Natural Resources. (2011). Phase 2 – Energy innovation roadmap – onshore wind/transmission in harsh environments. Retrieved from www.nati.net/media/9102/rfp_ph2eir_onshore_wind.doc

Department of Natural Resources. (2012). Environmental Benefits of Closing the Holyrood Thermal Generating Station. Retrieved from http://powerinourhands.ca/pdf/muskratenvironment.pdf

Department of Natural Resources. (2012a). Electricity demand forecast: Do we need the power? Retrieved from http://www.powerinourhands.ca/pdf/Electricity-Demand-Forecast-Do-We-Need-the-Power.pdf

Department of Natural Resources. (2015, July). About the department. Retrieved from http://www.nr.gov.nl.ca/nr/department/index.html

Department of Natural Resources. (2016). Electricity. Retrieved from http://www.nr.gov.nl.ca/nr/energy/electricity/

Department of Natural Resources. (2016). Publications – Energy. Retrieved from http://www.nr.gov.nl.ca/nr/publications/energy/#reports

Devine-Wright, P., ed. 2011. *Renewable energy and the public: From NIMBY to participation.* London, UK: Earthscan.

DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy*, *39*(3), 1699-1710.

Díaz-González, F., Sumper, A., Gomis-Bellmunt, O., & Villafáfila-Robles, R. (2012). A review of energy storage technologies for wind power applications. *Renewable and Sustainable Energy Reviews*, *16*(4), 2154-2171.

Ding, D., Maibach, E. W., Zhao, X., Roser-Renouf, C., & Leiserowitz, A. (2011). Support for climate policy and societal action are linked to perceptions about scientific agreement. *Nature Climate Change*, *1*(9), 462-466.

Drake, B., & Hubacek, K. (2007). What to expect from a greater geographic dispersion of wind farms?—A risk portfolio approach. *Energy Policy*, *35*(8), 3999-4008.

Dunlap, R. E., & McCright, A. M. (2011). Organized climate change denial. In: Dryzek, J., Norgaard, R., Schlosberg, D. (Eds.), The Oxford Handbook of Climate Change and Society (pp.144-160). New York, NY: Oxford University Press.

Dunn, B., Kamath, H., & Tarascon, J. M. (2011). Electrical energy storage for the grid: a battery of choices. *Science*, *334*(6058), 928-935.

Edenhofer, O., Madruga, R. P., & Sokona, Y. (Eds). (2012). Renewable energy sources and climate change mitigation: A special report of the Intergovernmental Panel on Climate Change. New York, NY: Cambridge University Press.

Elliott, E. D. (2013). Why the United States Does Not Have a Renewable Energy Policy. *Environmental Law Institute 43*(2): 10095-10101.

Emera. (2015). Maritime link. Retrieved from http://www.mitc.com/wp-content/uploads/2015/02/Maritime-Link-Project-Emera.pdf?62ff4e

Energy Policy and Management Centre. (2016). Energy in Canada: A statistical overview. Retrieved from http://www.ivey.uwo.ca/cmsmedia/2110828/energy-in-canada-a-statistical-overview.pdf

Energy Storage Association. (2016). Unleashing the power of energy storage. Retrieved from http://energystorage.org/energy-storage

Environmental Protection Agency. (2015, July). The Social Cost of Carbon. Retrieved from http://www3.epa.gov/climatechange/EPAactivities/economics/scc.html

Erickson, W. P., & Johnson, G. D., & Stickland, M. D., & Young, D. P., & Jr. Karyn, J., & Good, R. E. (2001). Avian collisions with wind turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States. Retrieved from http://www.west-inc.com/reports/avian_collisions.pdf

Erp, F. (1997). *Siting Processes for Wind Energy Projects in Germany*. Eindhoven University of Technology: Eindhoven.

European Commission. (1995). ExternE: Externalities of Energy. Brussels, LU: Author.

European Environment Agency. (2004). Energy subsidies in the European Union: A brief overview. Retrieved from http://www.eea.europa.eu/publications/technical_report_2004_1/

European Union: ILO Skills and Employability Department. (2011). Skills and occupational needs in renewable energy. Geneva, CH: Author.

European Wind Energy Association. (2008). Part 2: Grid integration. Retrieved from http://www.wind-energy-the-facts.org/wind-energy-penetration-and-integration.html

Feehan, J. P. (2014, April). Report on the allocation of the rural deficit. Retrieved from http://www.pub.nl.ca/applications/NLH2013GRA/files/reports/Feehan-Report-Apr25-14.pdf

Fisher, K., Iqbal, M. T., & Fisher, A. (2009). Small scale renewable energy resources assessment for Newfoundland. Project Report. The Harris Centre.

Fitzpatrick, A. (2016, March 28). Prepare for higher power bills. *The Telegram.* Retrieved from http://www.thetelegram.com/Business/2016-03-28/article-4479663/Prepare-for-higher-power-bills/1

Flavin, C., Gonzalez, M., Majano, A. M., Ochs, A., da Rocha, M., & Tagwerker, P. (2014). *Study on the development of the renewable energy Market in Latin America and the Caribbean*. Washington, D.C.: Inter-American Development Bank.

Gagnon, Y., & Leclerc, A., & Landry, M. A. (2009). Economic impact assessment of a 100MW wind farm project in New Brunswick. Retrieved from http://www.shearwind.com/media/pdf/eco_100mw_2009.pdf

Gipe, P., & Murphy, G. (2005). Ontario landowner's guide to wind energy. Retrieved from http://www.ontario-sea.org/Storage/28/1997_Ontario_Landowners_Guide_to_Wind_Energy.pdf

Global Wind Energy Council. (2015). Global statistics. Retrieved from http://www.gwec.net/global-figures/graphs/

Goulder, L. H., & Schein, A. R. (2013). Carbon taxes vs. cap and trade: A critical review. *Climate Change Economics, 4*(3): 1-28.

Government of Newfoundland and Labrador. (2007). *Focusing our Energy: Newfoundland and Labrador Energy Plan.* St. John's, NL.

Government of Newfoundland and Labrador. (2008). Nalcor Energy – The future of energy development in Newfoundland and Labrador. Retrieved from http://www.exec.gov.nl.ca/exec/ccee/

Government of Newfoundland and Labrador. (2011). Charting our course: Climate change action plan 2011. Retrieved from http://www.exec.gov.nl.ca/exec/ccee/publications/climate_change.pdf

Hamilton, L. C. (2011). Education, politics and opinions about climate change evidence for interaction effects. *Climatic Change, 104*(2), 231-242. Doi: 10.1007/s10584-010-9957-8

Harris, J. M. (2006). *Environmental and natural resource economics: A contemporary approach* (2nd ed.). New York, NY: Houghton Mifflin Company.

Hatch. (2012, August). Wind integration study – Isolated island. Retrieved from http://www.powerinourhands.ca/pdf/HatchWindIntegrationStudy.pdf

Haw, L., Sopian, K., & Sulaiman, Y. (2009, February). Public response to residential building integrated photovoltaic system (BIPV) in Kuala Lumpur urban area. In *Proceedings of the 4th IASME/WSEAS International Conference on Energy and Environment, Cambridge, UK* (pp. 212-219).

Hayes, M. A. (2013). Bats killed in large numbers at United States wind energy facilities. *BioScience*, *63*(12), 975-979.

Health Canada. (2009, 13 October). Understanding the health effects of climate change. Retrieved from http://www.hc-sc.gc.ca/ewh-semt/climat/impact/index-eng.php

Heath, Y., & Gifford, R. (2006). Free-market ideology and environmental degradation: The case of belief in global climate change. *Environment and Behavior, 38*(1), 48–71. doi:10.1177/0013916505277998

Heritage Newfoundland and Labrador. (2016). Winter. Retrieved from http://www.heritage.nf.ca/articles/environment/seasonal-winter.php

Heymann, J., & Barrera, M. (Eds.). (2013). *Ensuring a Sustainable Future: Making Progress on Environment and Equity*. London, UK: Oxford University Press.

Hoggan, J. (2009). *Climate cover-up: the crusade to deny global warming.* Vancouver, BC: Greystone Books.

Holttinen, H. (2005). Optimal electricity market for wind power. *Energy Policy*, *33*(16), 2052-2063.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277-1288.

Institute for Energy Research. (n.d.). Energy Overview. Retrieved from http://instituteforenergyresearch.org/topics/encyclopedia/energy-overview/

Intergovernmental Panel on Climate Change. (2007) Climate change 2007: synthesis report. Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_full_report.pdf

Intergovernmental Panel on Climate Change. (2007). IPCC fourth assessment report: The physical science basis. Retrieved from https://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspm-projections-of.html

Intergovernmental Panel on Climate Change. (2013). *Climate Change 2013: The physical science basis, contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change.* Retrieved from: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

Intergovernmental Panel on Climate Change. (2013). Summary for policy makers. Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

Intergovernmental Panel on Climate Change. (2014). Summary for policy makers. Retrieved from http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf

International Energy Agency. (2007, April). Contributions of renewables to energy security. Retrieved from http://www.deres.org.uy/practicas_pdf/cambio_climatico/Contribution_of_renewables_to_energy_security.pdf

International Energy Agency. (2009). *World Energy Outlook 2009.* Paris, FR: OECD Publishing.

International Energy Agency. (2014). World energy outlook 2014. Retrieved from http://www.iea.org/textbase/npsum/weo2014sum.pdf

International Energy Agency. (2015). World energy outlook 2015 factsheet. Retrieved from https://www.iea.org/media/news/2015/press/151110_WEO_Factsheet_GlobalEnergyTrends.pdf

International Energy Agency. (2015b). Key world energy statistics. Retrieved from http://www.iea.org/publications/freepublications/publication/KeyWorld_Statistics_2015.pdf

International Institute for Sustainable Development. (2013). A guide book to fossil-fuel subsidy reform: For policy-makers in southeast Asia. Retrieved from https://www.iisd.org/gsi/sites/default/files/ffs_guidebook.pdf

International Institute for Sustainable Development. (2014, December). The impact of fossil fuel subsidies on renewable electricity generation. Retrieved from http://www.iisd.org/sites/default/files/publications/impact-fossil-fuel-subsidies-renewable-electricity-generation.pdf

International Renewable Energy Agency. (2012). Policy challenges for renewable energy development in pacific island countries and territories. Retrieved from https://www.irena.org/DocumentDownloads/Publications/Policy_Challenges_for_Renewable_Energy_Deployment_PICTs.pdf

International Renewable Energy Agency. (2012a). Renewable energy technologies: Cost analysis series. Retrieved from https://www.irena.org/documentdownloads/publications/

International Union for the Conservation of Nature. (1991). *Caring for the earth: a strategy for sustainable living.* Geneva: CH: Author.

Jackson, S., & Barber, M. (2016) Historical and contemporary waterscapes of North Australia: Indigenous attitudes to dams and water diversions. *Water History*, 1-20.

Jackson, T. (2011). *Prosperity without growth: Economics for a finite planet*. New York, NY: Routledge.

Jagadeesh, A. (2000). Wind energy development in Tamil Nadu and Andhra Pradesh, India Institutional dynamics and barriers—A case study. *Energy Policy*, *28*(3), 157-168.

Jennings, P., & Lund, C. (2001). Renewable energy education for sustainable development. *Renewable Energy*, *22*(1), 113-118.

Jewer, P., Iqbal, M. T., & Khan, M. J. (2005). Wind energy resource map of Labrador. *Renewable Energy*, *30*(7), 989-1004.

Jones, G. (2010, September 15). Wind-hydrogen-diesel energy project. Retrieved from http://newenergy.is/gogn/eldra_efni/naha/presentations/whd_energy_project__gj_for_naha_ramea_tour__sept_8.pdf

Kammen, D. M., Kapadia, K., & Fripp, M. (2004). *Putting renewables to work: How many jobs can the clean energy industry generate.* RAEL Report, University of California: Berkele.

Khan, M. J., & Iqbal, M. T. (2004). Wind energy resource map of Newfoundland. *Renewable energy*, *29*(8), 1211-1221.

Keough, E. (2013, August 22). Newfoundland and Labrador Hydro – Isolated diesel systems. Retrieved from https://prezi.com/ck2xplydchow/newfoundland-labrador-hydro-isolated-diesel-systems/

Kumar, R. (2014). *Research methodology: A step-by-step guide for beginners.* Thousand Oaks, CA: Sage Publications.

Kaufman, N. (2016). Carbon tax vs. cap-and-trade: What's a better policy to cut emissions? Retrieved from http://www.wri.org/blog/2016/03/carbon-tax-vs-cap-and-trade-what%E2%80%99s-better-policy-cut-emissions

Kurpas, D., Mroczek, B., Karakiewicz, B., Kassolik, K., & Andrzejewski, W. (2013). Health impact of wind farms. *Annals of Agricultural and Environmental Medicine*, *20*(3).

Lacroix, A. (2011, June 2). Wind-diesel R&D at Natural Resources Canada. Retrieved from https://www.pembina.org/reports/wind-diesel-2-antoine-lacroix.pdf

Lantz, E., & Flowers, L. (2010). Scoping and framing social opposition to U.S. wind projects. Retrieved from http://www.nrel.gov/docs/fy10osti/47969.pdf

Ledec, G. C., Rapp, K. W., & Aiello, R. G. (2011). *Greening the wind: environmental and social considerations for wind power development.* Washington, DC: World Bank.

Liu, H., Masera, D. and Esser, L., eds. (2013). *World Small Hydropower Development Report 2013*. Hangzhou, Zhejiang: United Nations Industrial Development Organization; International Center on Small Hydro Power. Retrieved from http://www.smallhydroworld.org/fileadmin/user_upload/pdf/WSHPDR_2013_Final_Report-updated_version.pdf

Logan, J., & Kaplan, S. M. (2009). Wind power in the United States: Technology, economic, and policy issues. In C. N. Osphey (Ed.), Wind power: Technology, economics and policies (pp. 1-46). New York, NY: Nova Science Publishers.

Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of personality and social psychology*, *37*(11), 2098.

Loss, S. R., Will, T., & Marra, P. P. (2013). Estimates of bird collision mortality at wind facilities in the contiguous United States. *Biological Conservation*, *168*, 201-209.

Luthra, S., Kumar, S., Garg, D., & Haleem, A. (2015). Barriers to renewable/sustainable energy technologies adoption: Indian perspective. *Renewable and Sustainable Energy Reviews*, *41*, 762-776.

Lynn, P. A. (2011). *Onshore and offshore wind energy: an introduction*. Toronto, ON: John Wiley & Sons.

Machol, B. and Rizk, S. (2013, February). Economic value of U.S. fossil fuel electricity health impacts. *Environmental International, 52,* 75-80. doi: 10.1016/j.envint.2012.03.003

Mahoney, M. J. (1977). Publication prejudices: An experimental study of confirmatory bias in the peer review system. *Cognitive therapy and research*, *1*(2), 161-175.

Malka, A., Krosnick, J. A., & Langer, G. (2009). The association of knowledge with concern about global warming: Trusted information sources shape public thinking. *Risk Analysis, 29*(5), 633-447. Doi: 10.1111/j.1539-6924.2009.01220.x

Market Research Associates. (2011, March 30). Strategic review of promising sectors. Retrieved from http://neia.org/wp-content/uploads/2013/08/ALL-SECTORS-Final-Report-IBDA-MRA-03-11-Rev.pdf

Martinot, E., & McDoom, O. (2000). Promoting energy efficiency and renewable energy. Retrieved from http://www.martinot.info/Martinot_McDoom_GEF.pdf

Massachusetts. Department of Environmental Protection, Department of Public Health. (2012, January). Wind turbine health impact study: Report of the independent expert panel. Retrieved from http://www.mass.gov/eea/docs/dep/energy/wind/turbine-impact-study.pdf

Mazdiyasni, O., and AghaKoychak, A. (2014). Substantial increase in concurrent droughts and heatwaves in the United States. *Proceedings of the National Academies of Sciences of the United States of America, 112*(37), 11484-11489. doi: 10.1073.1422945112

McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *The Sociological Quarterly*, *52*(2), 155-194.

Meadows, D. H. (1972). Club of Rome. *The Limits to growth; a report for the Club of Rome's project on the predicament of mankind*. Universe, New York: NY.

Menz, F. C., & Vachon, S. (2006) The Effectiveness of Different Policy Regimes for Promoting Wind Power: Experiences from the States. *Energy Policy, 34*(14): 1786-1796

Michelsen, C. C., & Madlener, R. (2016). Switching from fossil fuel to renewables in residential heating systems: An empirical study of homeowners' decisions in Germany. *Energy Policy*, *89*, 95-105.

Milligan, M., Parsons, B., Smith, J. C., DeMeo, E., Oakleaf, B., Wolf, K., ... & Nakafuji, D. (2006). *Grid impacts of wind variability: recent assessments from a variety of utilities in the United States*. Report No. NREL/CP-500-39955. Golden, CO: National Renewable Energy Laboratory (NREL). http://www. uwig. org/Ewec06gridpaper. pdf.

Mills, A., Wiser, R., & Porter, K. (2009). The cost of transmission for wind energy: A review of transmission planning studies. Retrieved from https://emp.lbl.gov/sites/all/files/report-lbnl-1471e.pdf

Mitchell, B. (2005). Integrated water resource management, institutional arrangements, and land-use planning. *Environment and planning A*, *37*(8), 1335-1352.

Mirza, U. K., Ahmad, N., Harijan, K., & Majeed, T. (2009). Identifying and addressing barriers to renewable energy development in Pakistan. *Renewable and Sustainable Energy Reviews*, *13*(4), 927-931.

Molina, M. G., & Alvarez, J. M. G. (2011). Technical and regulatory exigencies for grid connection of wind generation, energy engineering. Retrieved from http://cdn.intechopen.com/pdfs/17118/InTech-Technical_and_regulatory_exigencies_for_grid_connection_of_wind_generation.pdf

Moore, F. C., & Diaz, D. B. (2015). Temperature impacts on economic growth warrant stringent mitigation policy. *Nature Climate Change*, *5*(2), 127-131.

Moore, M., Turcotte, A., Winter, J., & Walp, P. B. (2013). Energy and Energy Literacy in Canada: A Survey of Business and Policy Leadership. *SPP Research Paper*, 6-10.

Moula, M. M. E., Maula, J., Hamdy, M., Fang, T., Jung, N., & Lahdelma, R. (2013). Researching social acceptability of renewable energy technologies in Finland. *International Journal of Sustainable Built Environment*, *2*(1), 89-98.

Musgrove, P. (2010). *Wind Power.* Cambridge, UK: Cambridge University Press.

Nalcor Energy. (2016). Current Nalcor releases. Retrieved from http://www.nalcorenergy.com/current-releases.asp

Nalcor Energy. (2012). Information Sheet: Newfoundland and Labrador Hydro Electricity Rates. Retrieved from: http://nalcorenergy.com/uploads/file/Rates%20Info%20Sheet.pdf

Nalcor Energy. (n.d.). Muskrat Falls Generating Facility. Retrieved from https://muskratfalls.nalcorenergy.com/project-overview/muskrat-falls-hydroelectric-generation-facility/

Nasirov, S., Silva, C., & Agostini, C. A. (2015). Investors' perspectives on barriers to the deployment of renewable energy sources in Chile. *Energies*,*8*(5), 3794-3814.

National Environmental Education and Training Foundation. (2002). Americans' low "energy IQ:" A risk to our energy future. Why America needs a refresher course on energy. Retrieved from https://www.neef**usa**.org/file/240/download?token=7703G5Ow

National Renewable Energy Laboratory. (2011). 2011 cost of wind energy review. Retrieved from http://www.nrel.gov/docs/fy13osti/56266.pdf

National Renewable Energy Laboratory. (2012). IEA wind task 26: The past and future cost of wind. Retrieved from https://www.ieawind.org/index_page_postings/WP2_task26.pdf

National Renewable Energy Laboratory. (2014, September). Transmission grid integration. Retrieved from http://www.nrel.gov/electricity/transmission/integration_costs.html

Natural Resources Canada. (2013). Ramea Island. Retrieved from https://www.nrcan.gc.ca/energy/renewable-electricity/wind/7319

Natural Resources Canada. (2015, December 18). About renewable energy. Retrieved from http://www.nrcan.gc.ca/energy/renewable-electricity/7295

Natural Resources Canada. (2016, January 21). Additional statistics on energy. Retrieved from http://www.nrcan.gc.ca/publications/statistics-facts/1239

Natural Resources Canada. (2016, June). About electricity. Retrieved from http://www.nrcan.gc.ca/energy/electricity-infrastructure/about-electricity/7359

Navigant. (2011, September). Independent supply decision review. Retrieved from http://www.nalcorenergy.com/PDF/lcp0923.pdf

Navigant. (2012, December 11). Net metering bill impacts and distributed energy subsidies. Retrieved from http://www.navigant.com/~/media/WWW/Site/Insights/Energy/Navigant%20Final%20Net%20Metering%20Impact%20Report_Revised%20Dec%2011.pdf

Newfoundland and Labrador Environmental Industry Association. (2014). Policy sheet – Renewable energy. Retrieved from http://www.pub.nf.ca/applications/MuskratFalls2011/files/exhibits/Exhibit61.pdf

Newfoundland and Labrador Environment Network. (n.d.). Retrieved from http://rcen.ca/affiliate/nlen

Newfoundland and Labrador Hydro. (2004, October). An Assessment of Limitations for Non-Dispatchable Generation on the Newfoundland Island System. Retrieved from http://www.pub.nf.ca/applications/MuskratFalls2011/files/exhibits/Exhibit61.pdf

Newfoundland and Labrador Hydro. (2009). Hardwood gas turbine plant life extension upgrades. Retrieved from http://www.pub.nf.ca/applications/NLH2009Capital/files/application/NLH2009Application-VolumeII-Report21.pdf

Newfoundland and Labrador Hydro. (2009a). Preliminary assessment of alternative energy potential in coastal Labrador. Retrieved from http://www.nr.gov.nl.ca/nr/publications/energy/preliminary_assessment_of_alternative_energy_potential_in_coastal_labrador.pdf

Newfoundland and Labrador Hydro. (2012). Generation planning issues: November 2012. Retrieved from http://www.pub.nf.ca/applications/IslandInterconnectedSystem/files/rfi/PUB-NLH-047.pdf

Newfoundland and Labrador Hydro. (2013, January). Hydro launches school electricity educational resource power your knowledge. Retrieved from http://www.nlhydro.com/hydro-launches-school-electricity-educational-resource-power-your-knowledge-jan-29-2013/

Newfoundland and Labrador Hydro. (2014). Meeting peak demand. Retrieved from http://hydroblog.nalcorenergy.com/meeting-peak-demand/

Newfoundland and Labrador Hydro. (n.d.). About hydro. Retrieved from https://www.nlhydro.com/about-hydro/

Newfoundland and Labrador Hydro. (n.d.). Power your knowledge: Wind. Retrieved from http://www.poweryourknowledge.com/wind.html

Newfoundland and Labrador Statistics Agency. (2015). Annual estimates of population for Canada, provinces and territories, from July 1, 1971 to July 1, 2015. Retrieved from http://www.stats.gov.nl.ca/statistics/population/PDF/Annual_Pop_Prov.PDF

Natural Resources Defense Council. (2009). Powering up renewable electricity: NRDC's roadmap for immediate and cost-effective renewables deployment. Retrieved from https://www.nrdc.org/sites/default/files/poweringup.pdf

Nunatsiavut Government. (2016). Lake Melville: avativut, kanuittailinnivut (our environment, our health). Retrieved from http://makemuskratright.com/wp-content/uploads/2016/04/Policymakersreport1.pdf

Oikonomou, E. K., Kilias, V., Goumas, A., Rigopoulos, A., Karakatsani, E., Damasiotis, M., ... & Marini, N. (2009). Renewable energy sources (RES) projects and their barriers on a regional scale: The case study of wind parks in the Dodecanese islands, Greece. *Energy Policy*, *37*(11), 4874-4883.

Office of Climate Change and Energy Efficiency. (2016, August). Office of Climate Change and Energy Efficiency. Retrieved from http://www.exec.gov.nl.ca/exec/ccee/

Office of Climate Change and Energy Efficiency. (n.d.). Greenhouse gas emissions: Current levels. Retrieved from http://www.turnbackthetide.ca/understanding/ghg-emissions.shtml#.Vv6LKMc-A_U

Office of Climate Change and Energy Efficiency. (2016). Clean energy resources. Retrieved from http://www.turnbackthetide.ca/government-action/clean-energy-resources.shtml

Oreskes, N., & Conway, E. M. (2010). *Merchants of doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming.* New York, NY: Bloomsbury Press.

Organization for Economic Cooperation and Development. (2003). Glossary of statistical terms. Retrieved from https://stats.oecd.org/glossary/detail.asp?ID=3215

Ouyang, X., & Lin, B. (2014). Impacts of increasing renewable energy subsidies and phasing out fossil fuel subsidies in China. *Renewable and Sustainable Energy Reviews*, *37*, 933-942.

Owen, A. D. (2006). Renewable energy: Externality costs as market barriers. *Energy policy*, *34*(5), 632-642.

Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. *Renewable energy*, *24*(1), 73-89.

Parent, O., & Ilinca, A. (2011). Anti-icing and de-icing techniques for wind turbines: Critical review. *Cold regions science and technology*, *65*(1), 88-96.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Thousand Oaks, CA: SAGE Publications.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods.* Thousand Oaks, CA: SAGE Publications, Inc.

Pedersen, E. (2011). Health aspects associated with wind turbine noise—Results from three field studies. *Noise Control Engineering Journal*, *59*(1), 47-53.

Phillip, D., & Mitchell, B. (2009). *Environmental Change and Challenge* (3rd ed.). Don Mills, ONT: Oxford University Press.

Piper, J. M. (2001). Barriers to implementation of cumulative effects assessment. *Journal of environmental assessment policy and management*, *3*(4), 465-481.

Powell, J. L. (2011). *The inquisition of climate science.* New York, NY: Columbia University Press.

Power Advisory LLC. (2009). Evaluation of opportunities and barriers to wind power exports from the maritime provinces to the US northeast. Retrieved from http://www.slideshare.net/johndalton/maritimes-wind-exports-to-new-england

Rangi, R. J., Templin, M., Carpentier, D. A. (1992, October). Canadian wind energy technical and market potential. Efficiency and Alternative Energy Technology Branch, Energy, Mines and Resources Canada: Ottawa, ON.

Reddy, S., & Painuly, J. P. (2004). Diffusion of renewable energy technologies—barriers and stakeholders' perspectives. *Renewable Energy*, *29*(9), 1431-1447.

Renewable Energy Policy Network. (2015). Renewables 2015: Global status report. Retrieved from http://www.ren21.net/category/ren21-publications/

Research and Development Corporation. (2014). Who we are. Retrieved from http://www.rdc.org/connect/who-we-are/

Richards, G., Noble, B., & Belcher, K. (2012). Barriers to renewable energy development: A case study of large-scale wind energy in Saskatchewan, Canada. *Energy Policy*, *42*, 691-698.

Roberts, T. (2016, May). ‘Party had to end’ for major projects in N.L., says APEC. *CBC News*. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/party-had-to-end-for-major-projects-in-n-l-says-apec-1.3086250

Rosenberg, D. M., Bodaly, R. A., & Usher, P. J. (1995). Environmental and social impacts of large scale hydroelectric development: who is listening?.*Global Environmental Change*, *5*(2), 127-148.

Rowlands, I. H. (2007). The development of renewable electricity policy in the province of Ontario: the influence of ideas and timing. *Review of Policy Research*, *24*(3), 185-207.

Sastresa, E. L., Usón, A. A., Bribián, I. Z., & Scarpellini, S. (2010). Local impact of renewables on employment: assessment methodology and case study. *Renewable and sustainable energy reviews*, *14*(2), 679-690.

Satresa, E. L., Uson, A., Bribian, A. Z., & Scarpellini, S. (2010). Local impact of renewable on employment: assessment methodology and caste study. *Renewable and Sustainable Energy Review, 14*, 689-690.

Schelly, C. (2014). Implementing renewable energy portfolio standards: The good, the bad, and the ugly in a two state comparison. *Energy Policy*, *67*, 543-551.

Scobie, M. (2016). Policy coherence in climate governance in Caribbean Small Island Developing States. *Environmental Science & Policy*, *58*, 16-28.

Selman, P. (2004). Barriers and bridges to sustaining cultural landscapes. *The New Dimensions of the European Landscape*, *4*, 93-102.

Shafiee, S., & Topal, E. (2009). When will fossil fuel reserves be diminished?. *Energy policy*, *37*(1), 181-189.

Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. *Noise and Health*, *13*(54), 333.

Shirley, R., & Kammen, D. (2015). Energy planning and development in Malaysian Borneo: Assessing the benefits of distributed technologies versus large scale energy mega-projects. *Energy Strategy Reviews*, *8*, 15-29.

Sims, R. E. H., Rogner, H. H., & Gregory, K. (2003). Carbon emission and mitigation cost comparisons between fossil fuel, nuclear and renewable energy resources for electricity generation. *Energy Policy, 31,* 1315-1326. Retrieved from https://www.iaea.org/OurWork/ST/NE/Pess/assets/Energy%20Policy%202003.pdf

Sovacool, B. K. (2013). The avian benefits of wind energy: A 2009 update. *Renewable Energy*, *49*, 19-24.

Spain. Foundation Biodiversity. (2010). Green jobs in a sustainable economy. Madrid, ES: Author.

Stacy, T. F., & Taylor, G. S. (2015). The levelized cost of electricity from existing generation resources. Retrieved from http://instituteforenergyresearch.org/wp-content/uploads/2015/06/ier_lcoe_2015.pdf

Statista. (2014). Approximate wind energy penetration in leading wind markets in 2014, by market. Retrieved from http://www.statista.com/statistics/217804/wind-energy-penetration-by-country/

Statistics Canada. (2016, January 6). Population and dwelling count highlight tables, 2011 census. Retrieved from http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/pd-pl/Table-tableau.cfm?LANG=Eng&T=101&S=50&O=A

Stiles, T. D. (2009). Renewable Resources and the Dormant Commerce Clause. *Envtl. & Energy L. & Pol'y J.*, *4*, 34.

Teel, T. L., Bright, A. D., Manfredo, M. J., & Brooks, J. J. (2006). Evidence of biased processing of natural resource-related information: a study of attitudes toward drilling for oil in the Arctic National Wildlife Refuge. *Society and Natural Resources*, *19*(5), 447-463.

The National Academies. (2008). *Ecological impacts of climate change.* Retrieved from http://oceanservice.noaa.gov/education/pd/climate/teachingclimate/ecological_impacts_of_climate_change.pdf

The National Aeronautics and Space Administration. (n.d.) Global warming. Retrieved from http://earthobservatory.nasa.gov/Features/GlobalWarming/page2.php

The Telegram. (2011). Lower Churchill before wind power. Retrieved from: http://www.thetelegram.com/Business/2011-01-22/article-2149121/Lower-Churchill-before-wind-power-/1

Thresher, R., Schreck, S., Robinson, M., & Veers, P. (2008, August). Wind energy status and future wind engineering challenges. In *proceedings of the 1st American association for wind engineering workshop. Vail, Colorado (USA)*.

Trudgill, S. (1990). *Barriers to a better environment.* London, UK: Bellhaven Press.

U.S. Energy Information Administration. (2014, September 9). International energy outlook 2014. Retrieved from https://www.eia.gov/forecasts/ieo/

U.S. Energy Information Administration. (2015, March 31). How much of U.S. carbon dioxide emissions are associated with electricity generation? Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=77&t=11

Ueckerdt, F., Hirth, L., Luderer, G., & Edenhofer, O. (2013). System LCOE: What are the costs of variable renewables?. *Energy*, *63*, 61-75.

Union of Concerned Scientists (2009, March). Clean power: Green jobs. Retrieved from http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/Clean-Power-Green-Jobs-25-RES.pdf

Union of Concerned Scientists. (2013). Benefits of renewable energy use. Retrieved from http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/public-benefits-of-renewable.html#.V9BB_sc-C8U

Union of Concerned Scientists. (n.d.). Benefits of renewable energy use. Retrieved from http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/public-benefits-of-renewable.html#globalwarming

Union of Nova Scotia Municipalities. (2015, April). Wind energy fact sheets for Nova Scotian municipalities: Supporting municipalities in making informed decisions on wind energy. Retrieved from http://www.unsm.ca/renewable-energy.html

United Nations Commission on Environment, Development. (1992). *The global partnership for environment and development: a guide to Agenda 21.* Geneva, CH: Author.

United Nations Environment Programme (2011). Towards a green economy: Pathways to sustainable development and poverty eradication. Retrieved from http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf

United Nations Environment Programme. (2006). Energy and the Millennium Development Goals. Retrieved from http://www.unmillenniumproject.org/documents/MP_Energy_Low_Res.pdf

United Nations Environment Programme. (2005). Issue paper: Bioenergy issue paper series. Retrieved from http://www.unep.org/bioenergy/Portals/48107/doc/issues/issuespaper/Issue%20Paper%204.pdf

United Nations. (1992, August 12). Annex I: Rio declaration on environmental and development. Retrieved from http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm

United States Department of Energy (2009). Annual report on U.S. wind power installation, cost, and performance trends: 2007. In C. N. Osphey (Ed.), Wind power: Technology, economics and policies (pp. 47-98). New York, NY: Nova Science Publishers.

United States of America. Energy Information Administration. (2005). Policies to Promote Non-hydro Renewable Energy in the United States and Selected Countries. Washington, DC: Author.

United States. Energy Information Administration. (2015, June). Levelized cost and levelized avoided cost of new generation resources in the annual energy outlook 2015. Washington, DC: Author.

Vallone, R. P., Ross, L., & Lepper, M. R. (1985). The hostile media phenomenon: biased perception and perceptions of media bias in coverage of the Beirut massacre. *Journal of personality and social psychology*, *49*(3), 577.

Verbruggen, A., Fischedick, M., Moomaw, W., Weir, T., Nadaï, A., Nilsson, L. J., ... & Sathaye, J. (2010). Renewable energy costs, potentials, barriers: Conceptual issues. *Energy Policy*, *38*(2), 850-861.

Victor, P. A. (2008). *Managing without growth: slower by design, not disaster*. Northampton, MA: Edward Elgar Publishing.

Victor, P. A., & Rosenbluth, G. (2007). Managing without growth. *Ecological Economics*, *61*(2), 492-504.

Wellness Coalition Avalon East. (2016). Newfoundland and Labrador Enviroment Network. Retrieved from http://www.wellnesscoalition-avaloneast.ca/item/221-newfoundland-labrador-environment-network-nlen

Wetzel, F. T., Kissling, W. D., Beissmann, H., & Penn, D. J. (2012). Future climate change drive sea-level rise: secondary consequences from human displacement for island biodiversity. *Global Change Biology, 18*(9), 2707-2719. doi: 10.1111/j.1365-2486.2012.02736.x

Wheeler, T., and von Braun, J. (2013). Climate change impacts on global food security. *Science, 341*(6145), 508-513. doi: 10.1126/science.1239402

Whitley, S., & van der Burg, L. (2015). Fossil fuel subsidy reform: from rhetoric to reality. Retrieved from http://2015.newclimateeconomy.report/wp-content/uploads/2015/11/Fossil-fuel-subsidy-reform_from-rhetoric-to-reality.pdf

Wiener, G. J., & Koontz, T. M. (2010). Shifting Winds: Explaining Variation in State Policies to Promote Small-Scale Wind Energy. *Policy Studies Journal, 38*(4): 629-651.

Wilkinson, J. (2015). Comparing the Causes for Different Carbon Pricing Policies: the Cases of California, British Columbia, and Quebec. *Letter from the Editors*, 31.

Wilson, J., & Anderson, J. (2006). What the Science Says: How we use it and abuse it to make health and environmental policy. In: Oates, W. (Ed). The RFF Reader in Environmental and Resource Policy. Washington, DC: Resource for the Future, 2006.

Winkler, H., & Marquand, A. (2009). Changing development paths: From an energy-intensive to low-carbon economy in South Africa. *Climate and Development*, *1*(1), 47-65.

Wiser, R., & Bolinger, M. (2008). 2008 wind technologies market report. Retrieved from http://www.nrel.gov/docs/fy09osti/46026.pdf

Wiser, R., Namovicz, C., Gielecki, M., & Smith, R. (2007). The experience with renewable portfolio standards in the United States. *The Electricity Journal*, *20*(4), 8-20.

Wizelius, T. (2007). *Developing wind power projects: theory and practice*. London, UK: Earthscan.

Wolsink, M. (2000). Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. *Renewable energy*, *21*(1), 49-64.

World Bank. (2015, December 10). Energy overview. Retrieved from http://www.worldbank.org/en/topic/energy/overview

World Commission on Environment, Development. (1987). *Our common future.* Oxford, UK: Oxford University Press.

World Economic Forum. (2012). Energy for economic growth. Retrieved from http://reports.weforum.org/energy-for-economic-growth-energy-vision-update-2012/

World Economic Forum. (2013). Lessons drawn from reform of energy subsidies. Retrieved from http://www3.weforum.org/docs/GAC13/WEF_GAC13_LessonsReformsEnergySubsidies_Report.pdf

World Health Organization. (2015, September). Climate change and health. Retrieved from http://www.who.int/mediacentre/factsheets/fs266/en/

World Wind Energy Association. (2010). *World Wind Energy Report 2009.* Bonn, Germany.

W3 Wind Energy Group. (2011, June). W3 wind energy feasibility study. Retrieved from http://www.waterloo.ca/en/contentresources/resources/living/wind_energy_feasibility_study.pdf

Xue, J. (2010, March). Arguments for and against economic growth. In*Conference Proceedings, 2nd Conference on Economic DeGrowth*.

Yin, R. K. (1994). *Case study research: design and methods.* (2nd ed.). Thousand Oaks, CA: Sage Publishers.

Yin, R. K. (2009). *Case study research: design and methods.* Thousand Oaks, CA: Sage Publishers.

Zhang, Y., & Wildemuth, B. M. (2009). Qualitative analysis of content. In B. Wildemuth (Ed.), *Applications of social research methods to questions in information and library science* (pp.222-231). Westport CT: Libraries Unlimited.

Zillman, D. N. (2008). *Beyond the carbon economy: energy law in transition*. New York, NY: Oxford University Press, USA.

47th General Assembly, First Session. (2012). Bill 61: An act to amend the electrical power control act, 1994, the energy corporation act and the hydro corporation act, 2007. Retrieved from http://www.assembly.nl.ca/business/bills/Bill1261.htm

APPENDIX A: Interview Questionnaire

Researcher: Nick Mercer
Interviewee:
Date and time:

Current State of Affairs

- Could you please introduce yourself, and describe the involvement of your organization/your involvement with wind energy in Newfoundland and Labrador (NL)
- How would you describe the current state of wind energy development in NL? (Select favourable, unfavourable, or not sure)
- Why is NL in that state right now?

Themes

- I'm going to ask you about six different themes concerning further development
- Themes will be derived from Trudgill's (1990) AKTESP Framework for Analysis: they are 'agreement', 'knowledge', 'technology', 'economics', 'social perception', and
'political will'

Agreement

- What do you see as the main impediments to wind energy development in NL?
- What do you see as the main benefits of wind energy development in NL?
- Is there any level of disagreement (among involved parties) regarding the impediments and benefits of wind energy development?
- Assuming that there is a fair level of agreement on the benefits of proceeding with wind energy development in NL, what is the level of agreement (among involved parties) regarding how to proceed with wind energy?
- Do agreement-related issues currently represent a barrier to wind energy development in NL? (select yes, no, not sure).

Knowledge

- What is the level of knowledge and education (among involved parties) about wind
  energy in NL? (i.e. are groups displaying informed or misinformed opinions?, are there course teachings about wind energy, are there courses preparing specialists to work in this industry in NL?)
- How would you describe the current level of research (among involved parties) regarding
  wind energy in NL?
- Do knowledge-related issues currently represent a barrier to wind energy development in NL? (select yes, no, not sure).

Technology

- How would you describe the province's current state of technology to support wind
  Energy development or expansion? (follow up on icing, intermittency, wind speeds, etc)
- Do technology-related issues currently represent a barrier to wind energy development in NL? (select yes, no, not sure).

Economic

- What are the major economic obstacles to and drivers for wind energy expansion? Are there any feasibility studies in the province concerning wind-energy development?
- Do you see any economic benefit to pursuing wind energy development?
- Please discuss the economic efficiency of small-scale vs. large-scale wind farms
- Do economic-related issues currently represent a barrier to wind energy development in NL? (select yes, no, not sure).

Social

- Does the general public understand wind energy development environmentally, technologically, and economically? Explain.
- How has the public been consulted on decisions regarding current wind energy projects
  and prospects for future development and investment?
- Do social-related issues currently represented a barrier to wind energy development in NL? (select yes, no, not sure).

Political

- How would you describe the current state of policy development/goal-setting regarding
  wind energy development?
- Are there political considerations that prevent wind energy development? Explain.
- Do political-related issues currently represent a barrier to wind energy development in NL? (select yes, no, not sure).

Other

- Are there any other major barriers that you see to wind energy expansion in NL? Explain.

Barrier Assessment

- Please rank from 1st to last, what you believe to be the most significant barrier to wind energy development in NL. (Use AKTESP Framework).

Wrap-Up

- Do you have any other comments to make on this issue? Explain.

Appendix B: Recruitment Letter

Environmental Policy Institute

Nicholas Mercer
Grenfell Campus: Memorial University of Newfoundland
3 Wilson Drive, Corner Brook, NL A2H 6W3
nmercer@grenfell.mun.ca
(709) 660-6425

September 25, 2014

Dr. John Doe, Chair Environmental Studies
Grenfell Campus: Memorial University of Newfoundland
20 University Drive
Corner Brook, NL A2H 5G4

Dear Dr. John Doe,

My name is Nicholas Mercer, and I am a graduate student within the Environmental Policy Institute at Grenfell Campus, Memorial University of Newfoundland. I am currently working on data collection for my thesis entitled “Barriers to Renewable Energy Development in Newfoundland and Labrador: A Case Study of Wind Energy Applying the AKTESP Framework for Analysis”. I am conducting my thesis research under the supervision of Dr. Gabriela Sabau, Associate Professor in Economics/Environmental Studies, and Dr. Andreas Klinke, Associate Professor in Environmental Policy. Given your expertise, I am writing to request a research interview for my project.

Wind energy has strong potential in Newfoundland and Labrador; our provincial energy strategy identifies that we have the strongest wind energy resources in North America. Despite this, Newfoundland and Labrador ranks third last amongst Canada’s provinces and territories in installed wind energy capacity; our 51.7MW exceeds only that of the Northwest Territories (9.2MW) and Yukon (0.81MW). A number of studies in this province have concluded that small-scale wind energy projects merit consideration as future generation options, and even have the potential to replace thermal generation in the province (Fisher, & Iqbal, & Fisher, 2009). Despite this, small-scale wind energy developments remain limited in the province.

The primary goal of my research is to investigate barriers to renewable energy development in the province of Newfoundland and Labrador; the current research will apply the AKTESP Framework for Analysis to investigate underlying barriers to wind energy development. A secondary objective of the current research is to explore policy options to encourage the development of renewable energy; these policy prescriptions will address the barriers to renewable energy development identified in the research. To accomplish these objectives, I will conduct semi-structured/open-ended expert interviews; these interviews will explore barriers to renewable energy development in the province and will last approximately 60 minutes.

Data collection for this project will take place between September 2015 and January 2016. Expert interviews will take place in-person/or via telephone depending on availability. If you are willing participate in this research, a list of interview questions will be sent to you prior to the interview date. With your permission, I wish to record the expert interviews, but hand-writing your responses is also an option. The information you provide will be handled as confidentially as possible. The information you provide will be used for academic and research purposes; additionally, results will be presented to policymakers within the federal and provincial Government. A free and informed consent form will be sent to you prior to the interview, your signature will be obtained prior to the beginning of the interview.

If you are willing to participate in this project, please confirm your availability for an interview by responding to this email at nmercer@grenfell.mun.ca. If you have any questions or concerns, I can be reached at 1(709)660-6425, or online at nmercer@grenfell.mun.ca. You can also contact my supervisor Dr. Sabau via email at gsabau@grenfell.mun.ca, or by telephone at 1(709)639-2552, if you have any additional inquires; or Dr. Klinke online at akilinke@grenfell.mun.ca, or by telephone at 1(709)639-4307.

I look forward to meeting you. Thank you for your support,

Nicholas Mercer